Residential Sprinkler Plan Review

RSPR-Student Manual

2nd Edition, 2nd Printing-October 2019



FEMA/USFA/NFA
RSPR-SM
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FEMA

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ACKNOWLEDGMENTS

The development of any National Fire Academy (NFA) course is a complex process aimed at providing students with the best possible learning opportunity we can deliver.

There are many players in course development, each of whom plays an equally important part in its success. We want to acknowledge their participation and contribution to this effort and extend our heartfelt thanks for making this quality product.

The following people participated in the creation of this course:

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COURSE GOAL

The goal of this course is to provide the students with the ability to verify that the design of the residential fire sprinkler system complies with national standards and a manufacturer's product data sheets. It does not address differences that may be adopted in any state and/or local ordinances. Discussions will revolve around the differences among the application of National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems*; 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*; 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*; and International Residential Code (IRC) P2904 that can be used as models in their own communities.

The students will examine sample plans in order to identify the technical components of residential sprinkler systems and to identify the sprinkler types that are required. Sample plans and manufacturer's product literature will be used to evaluate sprinkler locations, to verify calculations of sprinkler flow, to determine if the correct number of sprinklers is accounted for, and to calculate the minimum pressure suggested by the manufacturer's specifications.

AUDIENCE, SCOPE AND COURSE PURPOSE

The target audience for the "Residential Sprinkler Plan Review" (RSPR) course is code officials whose responsibility is to review residential sprinkler plans. Such officials include fire inspectors, fire marshals and building code inspectors with at least one year of experience on the job.

Students should possess the ability to read and comprehend standard residential sprinkler plans at a basic level. They should be able to identify symbols, trace the system, differentiate between construction plans and residential sprinkler system plans, and read and interpret sprinkler plan notes and their accompanying legend. The students should have a conceptual understanding of existing standards NFPA 13, 13D, 13R and IRC P2904.

The purpose of this course is to provide students with the ability to verify that the design of the residential fire sprinkler system is in compliance with national standards and codes to aid in the detection and control of residential fires and, consequently, to provide protection against injury, loss of life and property damage.

GRADING METHODOLOGY

Assessment

Each student will be given a plans review assessment and final exam which will constitute 60% of the final grade. The passing criterion for the course will be 70% or higher.

Final Course Grade

Activity	Percent of Final Grade
Discussion	15
Student Activities	25
Final Assessment	60

Score Range	Letter Grade to be Assigned to Student
90-100	A
80-89	B
70-79	C
69 or less	F

Required Reading Assignments

Unit 1: Design and Installation Standards, Appendix C: The Makeover

Student completion of reading assignments will be done via evaluation of their class participation and will not be a separately graded activity.

Suggested Readings

Suggested readings are not evaluated but may enhance the student's understanding and promote discussion of course material.

Bryan, J. L. (2007). Residential sprinkler systems. In Dubay, C. (Ed.) *Automatic sprinkler systems for residential occupancies handbook* (pp 223-269). Retrieved from https://www.nfpa.org/~/media/Files/forms%20and%20premiums/NF13DR07_CHS4.pdf

Hugo, J. (2017-2018). *Guide to fire sprinkler changes in the 2018 IFC, IBC, IRC and IEBC.* Retrieved from https://nfsa.org/wp-content/uploads/2018/03/2018-IFC-IBC-IEBC-Guide.pdf

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Koffel, W. (2013). The latest in antifreeze sprinkler systems. *Emerging Trends enewsletter*. Retrieved from https://www.sfpe.org/page/FPE_ET_Issue_59/The-Latest-in-Antifreeze-Sprinkler-Systems-.htm

Rodriguez, M. (June 22, 2015). Tech topic: Residential fire sprinkler system design. *Reeves Journal*. Retrieved from https://www.reevesjournal.com/articles/88439-tech-topic-residential-fire-sprinkler-system-design

Sweet, J. (July 7, 2014). Residential fire sprinklers: Required in California for a while, what do contractors think? *Reeves Journal*. Retrieved from https://www.reevesjournal.com/articles/88025-residential-fire-sprinklers

SCHEDULE

TIME	DAY 1	DAY 2
8:00 - 9:30	Introduction, Welcome and Administrative	Unit 3: Pipe, Valves and Trim (cont'd) Activity 3.2: Identifying Head-Loss Values Caused by Domestic Water Meters
9:30 - 9:40	*Break*	*Break*
9:40 - 10:40	Unit 1: Design and Installation Standards Activity 1.1: Selecting Sprinkler Design and Installation Standards	Unit 4: Sprinklers and Sprinkler Layout
10:40 - 10:50	*Break*	*Break*
10:50 - 12:30	Unit 2: Water Supplies Activity 2.1: Calculating Minimum Water Supply Requirements — Residential Activity 2.2: Calculating Minimum Water Supply Requirements	Unit 4: Sprinklers and Sprinkler Layout (cont'd) Activity 4.1: Sprinkler Installation, Omissions and Configurations Unit 5: Verifying Sprinkler Coverage and Hydraulic Design
12:30 - 1:30	*Lunch Break*	*Lunch Break*
1:30 - 2:30	Unit 3: Pipe, Valves and Trim	Unit 5: Verifying Sprinkler Coverage and Hydraulic Design (cont'd) Activity 5.1: Verifying Hydraulic Design Assumptions Unit 6: Prescriptive Design
2:30 - 2:40	*Break*	*Break*
2:40 - 5:00	Unit 3: Pipe, Valves and Trim (cont'd) Activity 3.1: Identifying Residential Sprinkler System Components	Unit 6: Prescriptive Design (cont'd) Activity 6.1: Completing a Residential Sprinkler System Available Pressure Equation Unit 7: Conclusion Activity 7.1: Plans Review Assessment Final Exam

Note: This schedule is subject to modification by the instructors and approved by the training specialist.

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FIREFIGHTER CODE OF ETHICS

Background

The Fire Service is a noble calling, one which is founded on mutual respect and trust between firefighters and the citizens they serve. To ensure the continuing integrity of the Fire Service, the highest standards of ethical conduct must be maintained at all times.

Developed in response to the publication of the Fire Service Reputation Management White Paper, the purpose of this National Firefighter Code of Ethics is to establish criteria that encourages fire service personnel to promote a culture of ethical integrity and high standards of professionalism in our field. The broad scope of this recommended Code of Ethics is intended to mitigate and negate situations that may result in embarrassment and waning of public support for what has historically been a highly respected profession.

Ethics comes from the Greek word ethos, meaning character. Character is not necessarily defined by how a person behaves when conditions are optimal and life is good. It is easy to take the high road when the path is paved and obstacles are few or non-existent. Character is also defined by decisions made under pressure, when no one is looking, when the road contains land mines, and the way is obscured. As members of the Fire Service, we share a responsibility to project an ethical character of professionalism, integrity, compassion, loyalty and honesty in all that we do, all of the time.

We need to accept this ethics challenge and be truly willing to maintain a culture that is consistent with the expectations outlined in this document. By doing so, we can create a legacy that validates and sustains the distinguished Fire Service institution, and at the same time ensure that we leave the Fire Service in better condition than when we arrived.



FIREFIGHTER CODE OF ETHICS

I understand that I have the responsibility to conduct myself in a manner that reflects proper ethical behavior and integrity. In so doing, I will help foster a continuing positive public perception of the fire service. Therefore, I pledge the following…

- Always conduct myself, on and off duty, in a manner that reflects positively on myself, my department and the fire service in general.
- Accept responsibility for my actions and for the consequences of my actions.
- Support the concept of fairness and the value of diverse thoughts and opinions.
- Avoid situations that would adversely affect the credibility or public perception of the fire service profession.
- Be truthful and honest at all times and report instances of cheating or other dishonest acts that compromise the integrity of the fire service.
- Conduct my personal affairs in a manner that does not improperly influence the performance of my duties, or bring discredit to my organization.
- Be respectful and conscious of each member's safety and welfare.
- Recognize that I serve in a position of public trust that requires stewardship in the honest and efficient use of publicly owned resources, including uniforms, facilities, vehicles and equipment and that these are protected from misuse and theft.
- Exercise professionalism, competence, respect and loyalty in the performance of my duties and use information, confidential or otherwise, gained by virtue of my position, only to benefit those I am entrusted to serve.
- Avoid financial investments, outside employment, outside business interests or activities that conflict with or are enhanced by my official position or have the potential to create the perception of impropriety.
- Never propose or accept personal rewards, special privileges, benefits, advancement, honors or gifts that may create a conflict of interest, or the appearance thereof.
- Never engage in activities involving alcohol or other substance use or abuse that can impair my mental state or the performance of my duties and compromise safety.
- Never discriminate on the basis of race, religion, color, creed, age, marital status, national origin, ancestry, gender, sexual preference, medical condition or handicap.
- Never harass, intimidate or threaten fellow members of the service or the public and stop or report the actions of other firefighters who engage in such behaviors.
- Responsibly use social networking, electronic communications, or other media technology opportunities in a manner that does not discredit, dishonor or embarrass my organization, the fire service and the public. I also understand that failure to resolve or report inappropriate use of this media equates to condoning this behavior.

Developed by the National Society of Executive Fire Officers

GRADING RUBRIC

Student Activity Grading Rubric (Group or Individual Activity)							
Excellent	**Good**	**Average**	**Fair**	**Poor**			
Performed at an exceptional level of mastery. Required no assistance or prompting. Thoroughly answered questions and participated in discussion while also directing other students to other sources of information.	Performed at an above average level of mastery. Required minimal assistance or prompting. Answered questions and participated in discussion sufficiently while providing other pertinent information.	Performed at an adequate level of mastery. Required some assistance or prompting. Answered questions and participated in discussion sufficiently.	Performed at a minimal level of mastery. Required a fair amount of assistance and prompting. Answered questions and participated in discussion with difficulty.	Performed at an inadequate level. Required significant assistance and prompting. Was unable to answer questions and participate in discussion.			
5 Points	**4 Points**	**3 Points**	**2 Points**	**1 Point**			
Exceptionally competent	Highly competent	Competent	Somewhat competent	Not competent			
Student number	Student name	Activity 1.1: Demonstrate understanding of the different installation standards.	Activity 2.1: Demonstrate understanding with the necessary calculations required to complete the activity.	Activity 5.1: Demonstrate the data needed and steps taken to complete an available pressure equation for a prescriptive design.	Activity 6.1: Identify relevant components on sprinkler plans that are required to complete the activity.	Overall: Participates with group and encourages others to share; listens attentively.	Total
1.							
2.							
3.							
4.							
5.							

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A Student Guide to End-of-course Evaluations



Ten Things You Can Do to Improve the National Fire Academy

The National Fire Academy takes its course evaluations very seriously. Your comments and suggestions enable us to improve your learning experience.

Unfortunately, we often get end-of-course comments like these that are vague and, therefore, not actionable. We know you are trying to keep your answers short, but the more specific you can be, the better we can respond.

Actual quotes from student evaluations:	Examples of specific, actionable comments that would help us improve the course:
1 "Update the materials."	• The (ABC) fire video is out-of-date because of the dangerous tactics it demonstrates. The available (XYZ) video shows current practices. • The student manual references building codes that are 12 years old.
2 "We want an advanced class in (fill in the blank)."	• We would like a class that enables us to calculate energy transfer rates resulting from exposure fires. • We would like a class that provides one-on-one workplace harassment counseling practice exercises.
3 "More activities."	• An activity where students can physically measure the area of sprinkler coverage would improve understanding of the concept. • Not all students were able to fill all ICS positions in the exercises. Add more exercises so all students can participate.
4 "A longer course."	• The class should be increased by one hour per day to enable all students to participate in exercises. • The class should be increased by two days so that all group presentations can be peer evaluated and have written abstracts.
5 "Readable plans."	• The plans should be enlarged to 11 by 17 and provided with an accurate scale. • My plan set was blurry, which caused the dotted lines to be interpreted as solid lines.
6 "Better student guide organization," "manual did not coincide with slides."	• The slide sequence in Unit 4 did not align with the content in the student manual from slides 4-16 through 4-21. • The instructor added slides in Unit 4 that were not in my student manual.
7 "Dry in spots."	• The instructor/activity should have used student group activities rather than lecture to explain Maslow's Hierarchy. • Create a pre-course reading on symbiotic personal relationships rather than trying to lecture on them in class.
8 "More visual aids."	• The text description of V-patterns did not provide three-dimensional views. More photographs or drawings would help me imagine the pattern. • There was a video clip on NBC News (date) that summarized the topic very well.
9 "Re-evaluate pre-course assignments."	• The pre-course assignments were not discussed or referenced in class. Either connect them to the course content or delete them. • The pre-course assignments on ICS could be reduced to a one-page job aid rather than a 25-page reading.
10 "A better understanding of NIMS."	• The instructor did not explain the connection between NIMS and ICS. • The student manual needs an illustrated guide to NIMS.

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UNIT 1: DESIGN AND INSTALLATION STANDARDS

TERMINAL OBJECTIVE

The students will be able to:

1.1 *Explain the scope of residential sprinkler system design and installation standards for National Fire Protection Association (NFPA) 13,* Standard for the Installation of Sprinkler Systems; *13D,* Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes; *13R,* Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies; *and International Residential Code (IRC) P2904, given scoping statement examples.*

ENABLING OBJECTIVES

The students will be able to:

1.1 *Differentiate one- and two-family dwellings, townhouses, manufactured homes, and other residential occupancies.*

1.2 *Differentiate the sprinkler system design and installation standards.*

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FEMA

U.S. Fire Administration

UNIT 1: DESIGN AND INSTALLATION STANDARDS

Slide 1-1

TERMINAL OBJECTIVE

Explain the scope of residential sprinkler system design and installation standards for National Fire Protection Association (NFPA) 13*, Standard for the Installation of Sprinkler Systems*; 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*; 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*; and International Residential Code (IRC) P2904, given scoping statement examples.

Slide 1-2

ENABLING OBJECTIVES

- Differentiate one- and two-family dwellings, townhouses, manufactured homes, and other residential occupancies.
- Differentiate the sprinkler system design and installation standards.

Slide 1-3

I. RESIDENTIAL SPRINKLER DESIGN AND INSTALLATION

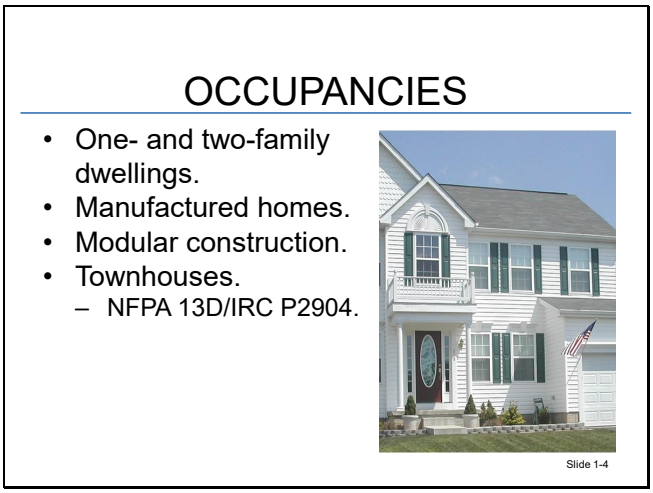
A. The code official or designated authority (i.e., third-party reviewer) may have the responsibility to review residential sprinkler system plans, hydraulic calculations (or prescriptive design), and components for compliance with national design and installation standards.

B. In those cases where plans are submitted, and to ensure that the code official has performed with due diligence, the code official should have a good understanding of the differences between and among the types of residential occupancies and how the sprinkler design standards are applied.

C. Functionally, all sprinkler systems are the same. They consist of a water supply, a network of pipes, valves and attachments (sometimes called "trim"), and automatic sprinklers that discharge water when they are subject to heat.

D. The differences among the national standards (National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems*; 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*; 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*; and International Residential Code (IRC) P2904) pertain to how sprinkler systems are designed and installed to provide an appropriate (and minimal) level of protection for the occupants and contents.

II. OCCUPANCIES AND STANDARDS



A. Occupancy description.

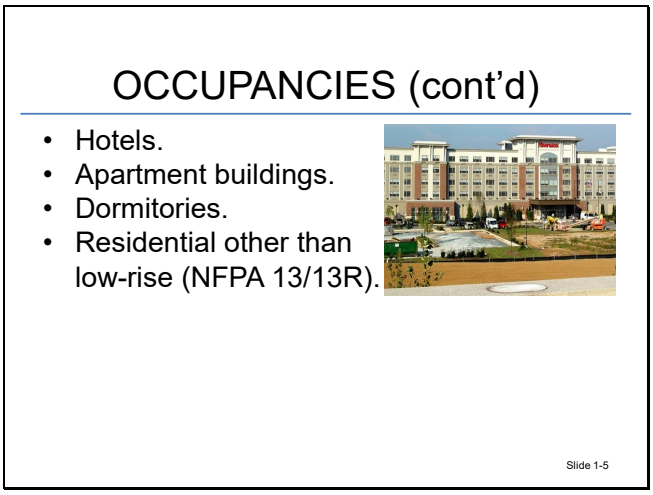
1. Before selecting the sprinkler design and installation standard that will be used to review and approve plans, the code official should identify the type of residential occupancy that is under consideration.

2. There are a variety of definitions that exist, depending upon the code or standard that is being used.

   a. Dwelling (from NFPA 13D): any building "that contains no more than two dwelling units intended to be used, rented, leased, let, or hired out to be occupied or that are occupied for habitation purposes" (2016).

   b. Manufactured home (from NFPA 13D): a structure, transportable in one or more sections, that is eight body feet or more in width or 40 body feet or more in length in the traveling mode; when erected on site is 320 square feet or more; is built on a chassis and designed to be used as a dwelling, with or without a permanent foundation; and is connected to the required utilities, including plumbing, heating, air conditioning and electrical systems, contained therein. Formerly known as "mobile homes" or "trailer coaches."

   c. Modular construction: a type of construction in which portions of the building are divided into modules or sections that are manufactured in a remote facility and delivered to a site for final assembly into a building. Regulated by local building code and treated as traditional "stick built" construction.



   d. Residential occupancies (from NFPA 13R): occupancies (up to and including four stories and no more than 60 feet in height) that include the following, as defined in NFPA 101, *Life Safety Code*®: apartment buildings, lodging and rooming houses, board and care facilities (prompt and slow evacuation type), hotels, motels, and dormitories.

OCCUPANCIES (cont'd)

- Assisted living.
- Personal care.
- Boarding homes.



Slide 1-6

e. Residential Group R (from IRC and International Building Code (IBC)): "the use of a building or structure, or portion thereof, for sleeping purposes when not classified" as an institutional occupancy or regulated by the IRC (2015). Residential Group R includes boarding homes, hotels, motels, apartments, dormitories, convents, fraternities and sororities, vacation time-share properties, adult living facilities (five or fewer less than 24 hours), child care facilities (five or fewer less than 24 hours), congregate living (less than 16 people), and residential care/assisted living (more than five but not more than 16 people).

f. Townhouse (from IRC): "a single-family dwelling unit constructed in a group of three or more attached units in which each unit extends from foundation to roof and with a yard or public way on not less than two sides" (2015).

OCCUPANCIES (cont'd)

- What type of residence?
- What standard(s)?



Slide 1-7

OCCUPANCIES (cont'd)

- What type of residence?
- What standard(s)?



Slide 1-8

OCCUPANCIES (cont'd)

- What type of residence?
- What standard(s)?



Slide 1-9

OCCUPANCIES (cont'd)

- What type of residence?
- What standard(s)?



Slide 1-10

OCCUPANCIES (cont'd)

- What type of residence?
- What standard(s)?



Slide 1-11

KNOWLEDGE CHECK

True or false: For fire sprinkler design, a three-story hotel and a three-story assisted living facility are the same type of occupancy. Explain your answer.

Slide 1-12

B. Residential sprinkler design and installation standards.

SPRINKLER STANDARDS

- NFPA 13.
  - Commercial- and industrial-type buildings.
  - Residential more than 60 feet above grade or more than four stories.
  - Residential exceeding building code area and height tables.



Slide 1-13

1. NFPA 13 is the standard for the design and installation of fire suppression sprinkler systems in commercial- or industrial-type buildings and applies to residential facilities more than 60 feet above grade, four stories in height, or that exceed building code limits for area and height.

   NFPA 13 is the original foundational standard for the installation and design of sprinkler systems. However, the configuration of the structure and the number of dwellings are the criteria used to determine which standard applies. If the residential standards are silent on an item, refer to NFPA 13.

SPRINKLER STANDARDS (cont'd)

- NFPA 13R.
  - Residential up to and including four stories and no more than 60 feet.



Slide 1-14

2. NFPA 13R is the standard for the design and installation of sprinkler systems in residential buildings up to and including four stories and no more than 60 feet in height above grade plane. Common 13R applications include hotels, apartment buildings and condominiums.

   a. "Story height" is left up to the locally adopted building code definition.

   b. Incidental nonresidential portions should be protected by NFPA 13 designs.

      - Parking garages.
      - Laundromats.
      - Hotel/Motel lobbies and service areas.
      - Retail or service shops.

PODIUM CONSTRUCTION

- NFPA 13 and 13R.
  - Residential up to and including four stories and no more than 60 feet.



Slide 1-15

3. IBC allows mixed-use "podium" construction.

   a. Lower floors must be Type IA fire-resistive construction.

   b. Lower floors must be separated from upper floors by three-hour fire-resistive horizontal assembly.

   c. Upper floors may be residential construction.

   d. Building below the horizontal assembly must be sprinklered per NFPA 13.

   e. Maximum total building height (in feet) for podium with residential may not exceed 70 feet above grade plane for Type VA and 60 feet for Type VB construction.

SPRINKLER STANDARDS (cont'd)

- NFPA 13D.
  - One- and two-family dwellings.
  - Manufactured homes.
  - Townhouses.





Slide 1-16

4. NFPA 13D is the standard for the design and installation of residential sprinkler systems in one- and two-family dwellings, manufactured homes and townhouses. Its purpose is to aid in the detection and control of residential fires; protect against injury, loss of life and property damage; and prevent flashover in the room of origin.

SPRINKLER STANDARDS (cont'd)

- IRC P2904.
  - One- and two-family dwellings.
  - Townhouses.





Slide 1-17

5. IRC P2904 is a prescriptive design and installation standard included in the plumbing requirements of the IRC that is considered equivalent to NFPA 13D for one- and two-family dwellings and townhouses.

KNOWLEDGE CHECK

Townhouse occupancy falls under which standard(s)?

A. NFPA 13.
B. NFPA 13R.
C. NFPA 13D.
D. IRC P2904.

Slide 1-18

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ACTIVITY 1.1

Selecting Sprinkler Design and Installation Standards

Purpose

Differentiate the sprinkler system design and installation standards, and select the appropriate standard for the application shown.

Directions

The instructor will show you a series of photographs of different residential occupancies. For each slide, answer the following questions:

1. Describe the type of residence shown.

2. Cite the minimum design and installation standard(s) for that type of residence.

   a. Slide 1-20: _____

   b. Slide 1-21: _____

   c. Slide 1-22: _____

   d. Slide 1-23: _____

   e. Slide 1-24: _____

   f. Slide 1-25: _____

   g. Slide 1-26: _____

   h. Slide 1-27: _____

   i. Slide 1-28: _____

   j. Slide 1-29: _____

   k. Slide 1-30: _____

   l. Slide 1-31: _____

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QUICK COMPARISON

	NFPA 13	NFPA 13R	NFPA 13D/IRC P2904
Scope	All occupancies	Group R to four stories and 60 feet in height	One- and two-family and townhouses
Coverage			
Sprinkler design			
Sprinklers			
Water demand			
Duration			
Fire Department Connection (FDC)			

Slide 1-32

III. SUMMARY

SUMMARY

- To apply the correct design and installation standard, the plans reviewer should know:
  - The differences between standards (NFPA 13, 13R, 13D and IRC P2904).
  - The occupancy of the structure.
  - The building's height and configuration.

Slide 1-33

SUMMARY (cont'd)

- NFPA 13R covers low- to mid-rise buildings:
  - Residential up to and including four stories and no more than 60 feet in height.
  - May be on top of "podium" construction.
- NFPA 13D and IRC P2904.

Slide 1-34

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REFERENCES

ICC. (2015). *International building code*. Washington, DC: Author.

ICC. (2015). *International residential code*. Washington, DC: Author.

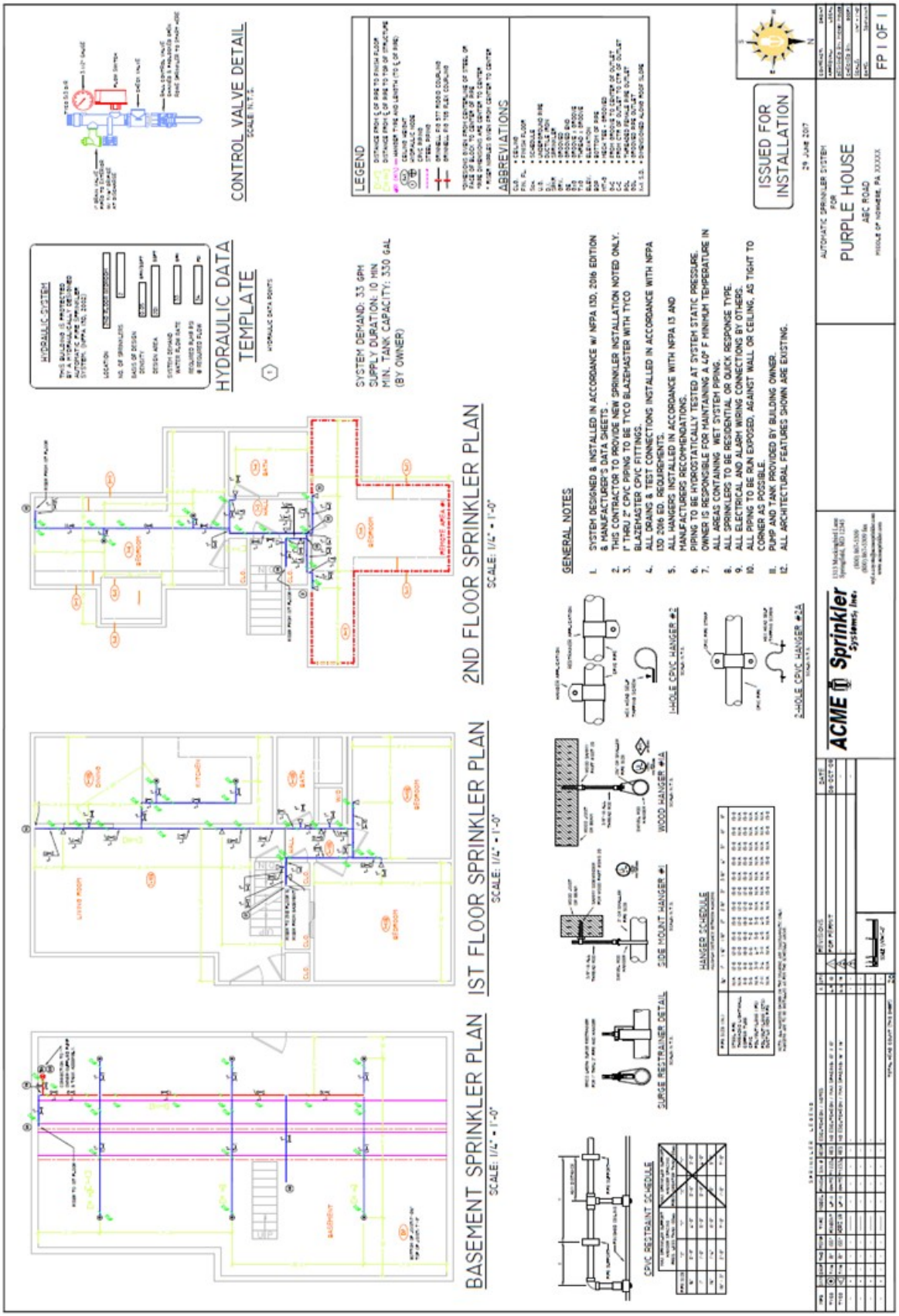
NFPA. (2016). *Standard for the installation of sprinkler systems in one- and two-family dwellings and manufactured homes*. (Standard No. 13D). Retrieved from www.nfpa.org

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APPENDIX A

OVERALL PLAN FOR THE PURPLE HOUSE RESIDENTIAL SPRINKLER SYSTEM

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CONTROL VALVE DETAIL
HYDRAULIC DATA TEMPLATE
LEGEND
ABBREVIATIONS
SYSTEM DEMAND: 33 GPM
SUPPLY DURATION: 10 MIN
MIN. TANK CAPACITY: 330 GAL
(BY OWNER)
2ND FLOOR SPRINKLER PLAN
SCALE: 1/4" = 1'-0"
1ST FLOOR SPRINKLER PLAN
SCALE: 1/4" = 1'-0"
BASEMENT SPRINKLER PLAN
SCALE: 1/4" = 1'-0"
GENERAL NOTES
1. SYSTEM DESIGNED & INSTALLED IN ACCORDANCE W/ NFPA 13D, 2016 EDITION & MANUFACTURER'S DATA SHEETS.
2. THIS CONTRACTOR TO PROVIDE NEW SPRINKLER INSTALLATION NOTED ONLY.
3. 1" THRU 2" CPVC PIPING TO BE TYCO BLAZEMASTER WITH TYCO BLAZEMASTER CPVC FITTINGS.
4. ALL DRAING & TEST CONNECTIONS INSTALLED IN ACCORDANCE WITH NFPA 13D 2016 ED. REQUIREMENTS.
5. ALL HANGERS INSTALLED IN ACCORDANCE WITH NFPA 13 AND MANUFACTURERS RECOMMENDATIONS.
6. PIPING TO BE HYDROSTATICALLY TESTED AT SYSTEM STATIC PRESSURE.
7. OWNER IS RESPONSIBLE FOR MAINTAINING A 40° F MINIMUM TEMPERATURE IN ALL AREAS CONTAINING WET SYSTEM PIPING.
8. ALL SPRINKLERS TO BE RESIDENTIAL OR QUICK RESPONSE TYPE.
9. ALL ELECTRICAL AND ALARM WIRING CONNECTIONS BY OTHERS.
10. ALL PIPING TO BE RUN EXPOSED, AGAINST WALL OR CEILING, AS TIGHT TO CORNER AS POSSIBLE.
11. PUMP AND TANK PROVIDED BY BUILDING OWNER.
12. ALL ARCHITECTURAL FEATURES SHOWN ARE EXISTING.
ISSUED FOR INSTALLATION
29 JUNE 2017
AUTOMATIC SPRINKLER SYSTEM FOR
PURPLE HOUSE
ABC ROAD
FP 1 OF 1
ACME Sprinkler Systems, Inc.

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APPENDIX B

QUICK COMPARISON CHART

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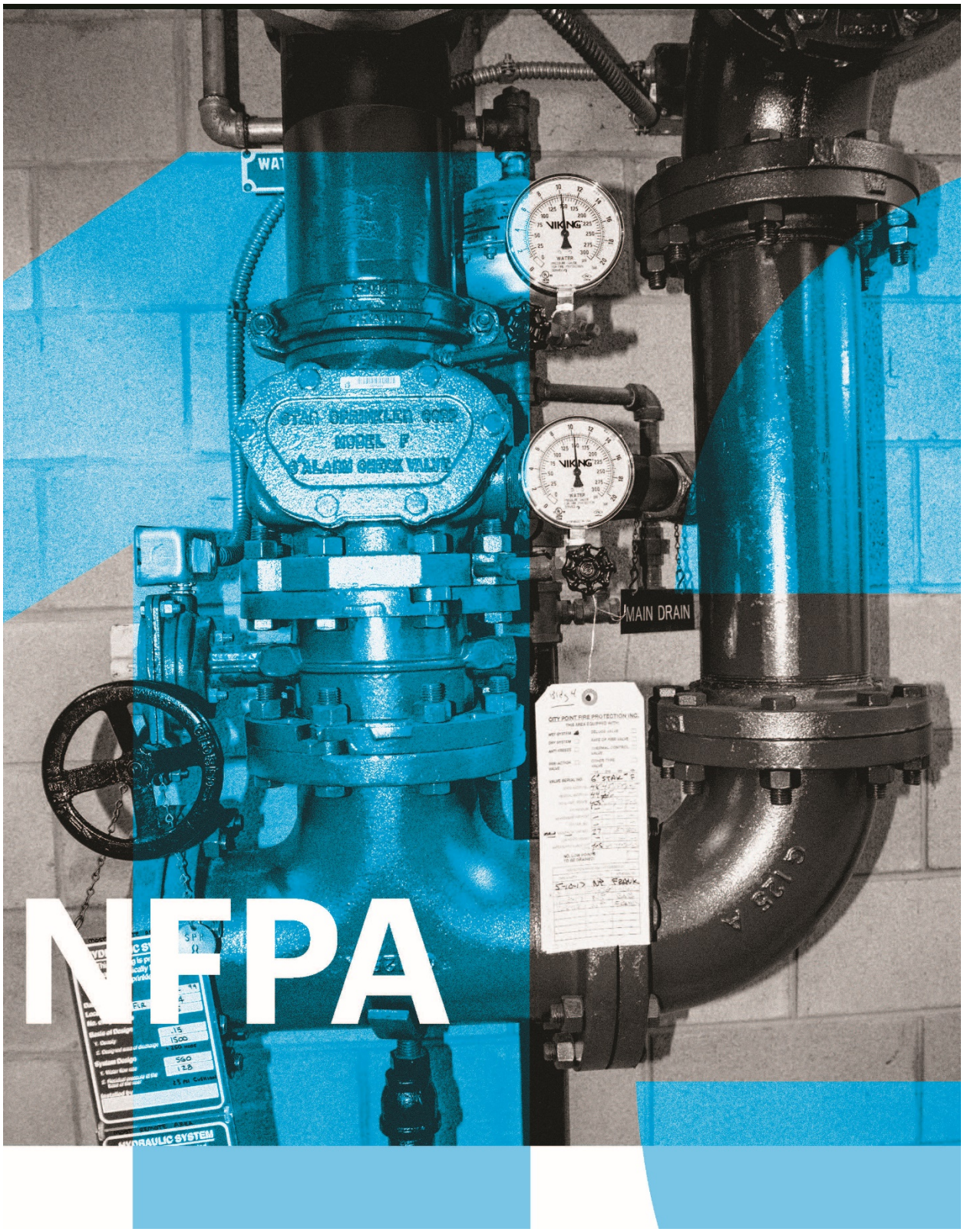
	NFPA 13	NFPA 13R	NFPA 13D/IRC P2904
Scope			
Coverage			
Sprinkler design			
Sprinklers			
Water demand			
Duration			
Fire Department Connection (FDC)			

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APPENDIX C

THE MAKEOVER

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NFPA
MAIN DRAIN
HYDRAULIC SYSTEM

LAS VEGAS NFPA CONFERENCE & EXPO 2018

THE MAKEOVER

A comprehensive reorganization of the 2019 NFPA 13 has resulted in a major standard that is a leaner, clearer, and more effective tool for the installation of sprinkler systems

by David Hague

A few years ago, as part of the preparation for the 2016 edition of NFPA 13, *Installation of Sprinkler Systems*, members of one of the standard's committees expressed concern over inconsistencies they had identified in the document. The standard had existed in one form or another since 1896, had undergone more than 60 revision cycles, and had grown to nearly 500 pages. Committee members realized that, in the process of all that change, some chapters had grown disproportionately large and had become difficult for users to manage and follow. Additionally, redundancies had crept into the standard, increasing its size without adding clarity. Committee members began discussing the possibility of restructuring the standard to address these issues.

The NFPA 13 Correlating Committee noted these concerns and established a task group to review the entire document and identify ways to clarify it and make it easier to use. The task group sought to remove redundancies that created confusion or conflict—repetition that improved usability was deemed appropriate, however—and to avoid repetition of general information throughout the standard. The flow of information was reviewed from chapter to chapter, with the idea of providing consistent chapter structures and combining, reordering, or dividing chapters where the flow was problematic. Chapter titles were checked for accuracy. The task group was charged with preparing a draft prior to the next revision cycle. ▶

13

The result of this effort is a major reorganization for the 2019 edition of NFPA 13. Information is now clearly separated by subject matter—sprinkler technology, storage method, commodity, and so on—and is organized in the order the information is needed for anyone planning a sprinkler system installation. (One of the first considerations when planning a sprinkler system, for example, is the available water supply. In the previous edition, water supply wasn't addressed until Chapter 24, so an engineer or designer had to constantly flip from front to back to reference the information. In the 2019 edition, water supply is addressed in Chapter 5.) The standard has been trimmed to about 400 pages. Overall, the 2019 edition offers users a clearer, more concise, and more effective tool for the installation of sprinkler systems.

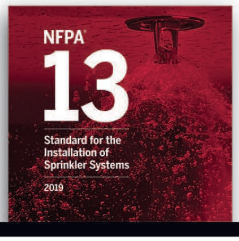
Much of the work on the new NFPA 13 is already complete. First and second draft meetings were held, and the notice of intent to make a motion (NITMAM) closing date has passed with no NITMAMs submitted related to the standard's reorganization. NFPA 13 will be presented to NFPA's membership at the upcoming 2018 Technical Session in Las Vegas in June. It is anticipated that the 2019 edition of NFPA 13 will be published later this year with an effective date of sometime in August.

Early technologies

The changes to the 2019 edition of NFPA 13 were nearly three centuries in the making.

The first known water-based fire extinguishing system was installed in England around 1723 and consisted of a container of water, a chamber of gunpowder, and a system of fuses, the operational logic being that a fire would ignite the fuses that would detonate the gunpowder, and the ensuing explosion would release the stored water on the blaze. The first sprinkler system used in the United States was a network of perforated pipes that was used in the mid-1800s. As its name suggests, the pipes were perforated with holes drilled at strategic points along their lengths. The system had to be activated manually and discharged throughout the area, not just over the fire—a rather inefficient method that wasted a lot of water. The first automatic sprinkler was invented in 1864, but it wasn't until 1878 when Henry Parmelee created an automatic sprinkler that saw extensive use.

In the late 1800s, sprinkler technology was advancing rapidly in the U.S.; in Boston alone, nine different sets of rules for the installation of sprinkler systems were in use. To address this issue, standardize installation, and prevent confusion surrounding different rules, a group of stakeholders, primarily insurance professionals, met in the Boston offices of the Underwriters Bureau of New England in 1895 to draft a set of uniform requirements for the installation of sprinkler systems.



AT-A-GLANCE HIGHLIGHTS OF THE NEW NFPA 13

- The standard is now organized in the order the information is needed for planning a sprinkler system installation.
- Information is now clearly separated by subject matter, such as sprinkler technology, storage method, and commodity.
- Repetition of general information has been removed throughout the standard. The document has been reduced from nearly 500 pages to about 400.
- Definitions of all terms used in NFPA 13, collected in Chapter 3, are now organized alphabetically rather than in groups by subject matter.
- Chapter 4, General Requirements, has been revised to include general information needed in the planning and design of a sprinkler system.

The result was "Rules and Regulations of the National Board of Fire Underwriters for Sprinkler Equipments, Automatic and Open Systems," published in 1896. The document was 25 pages long. "The Red Book," as it came to be known, was the standard that led to the creation of NFPA 13, as well as NFPA itself, which was founded in 1896.

In 1897, Everett U. Crosby, NFPA's first secretary of the association, outlined the principles used in establishing the sprinkler standard, effectively describing the process that continues to be used to guide NFPA technical committees to this day. The purpose of the association, he wrote, was "to bring together the experience of different sections and different bodies of underwriters, to come to a mutual understanding, and, if possible, an agreement on general principles governing fire protection. Additionally, he wrote, the process existed "to harmonize and adjust our differences so that we may go before the public with uniform rules and conditions which may appeal to their judgment."

In the 1960s, the NFPA 13 Technical Committee was charged with evolving the standard to encourage innovation and technology while keeping system installation costs in check. This was done with the intent of making systems available on a wider basis to further reduce fire loss. The effort resulted in the development of new types of pipe, fittings, and sprinklers, as well as the introduction of hydraulic calculations. In the 1980s and 1990s, sprinkler technology exploded with the introduction of the quick response sprinkler, early suppression fast response (ESFR) technology, control mode density area sprinklers, control mode specific application (CMSA) sprinklers, extended coverage sprinklers, and more, and NFPA 13 grew accordingly to address the plethora of new technologies.

Following the 1996 edition of NFPA 13, the technical committee was expanded to accommodate the need for additional technical expertise. The committee was organized into a technical correlating committee (TCC) that oversaw the entire project. The TCC

supervised the work of committees on hanging and bracing, sprinkler system discharge criteria, and sprinkler system installation. The Technical Committee on Private Water Supply Piping Systems, part of the organization of NFPA 24, *Installation of Private Fire Service Mains and their Appurtenances*, was added before the 2002 edition. The Technical Committee on Residential Sprinkler Systems—part of the organization of NFPA 13D, *Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, and NFPA 13R, *Installation of Sprinkler Systems in Low-Rise Residential Occupancies*—was added prior to the 2007 edition, as was the Technical Committee on Foam-Water Sprinkler and Foam-Water Spray Systems.

For the 1999 edition, the technical committee decided to include all sprinkler requirements in a significant reorganization of the standard. As part of that effort, language from approximately 40 NFPA codes and standards was added, including the entire text of all of the storage documents, including NFPA 231, *Indoor General Storage*, NFPA 231C, *Rack Storage of Materials*, NFPA 231D, *Storage of Rubber Tires*, NFPA 231E, *Recommended Practice for the Storage of Baled Cotton*, and NFPA 231F, *Storage of Roll Paper*.

Retooling a major standard

While the contemporary NFPA 13 was comprehensive, it was also due for a big-picture makeover.

As part of the reorganization of the 2019 edition of the standard, the task group developed a spreadsheet showing every section of NPFA 13 in detail. The spreadsheet contained more than 8,000 lines and was developed to help the task group keep track of every line of text in the standard. As part of the document's reorganization by subject matter, individual lines of text were moved to new locations throughout the standard. While deciding where to place those lines in the new format, almost 500 lines of redundant text were proposed (and accepted by the committees) for elimination. Chapters have been renumbered.

Chapter 1, Administration, and Chapter 2, Referenced Publications, remain essentially unchanged from the previous edition, although the former Section 4.1 Level of Protection was moved to Chapter 1. Chapter 3, Definitions, was rewritten to structure all the definitions of terms used in NFPA 13 alphabetically rather than in groups by subject matter. Feedback from users had indicated that it was difficult to find definitions in the current subject matter organization.

Chapter 4, General Requirements, was revised to include general information needed in the planning and design of a sprinkler system. The chapter begins with the expected level of protection as in previous editions, but now includes occupancy classification since that information is the primary step in determining the design and layout of a sprinkler system. Limitations on system size have also been moved to this chapter.

Chapter 5, Water Supplies, now contains water supply information that was previously located in Chapter 24; the task group felt that this information belonged in the front of the standard, since this is the first step in planning a sprinkler system. Chapter 6, Installation of Underground Piping, formerly Chapter 10, includes requirements for underground piping systems and logically follows water supplies.

Chapter 7, Requirements for System Components and Hardware (formerly Chapter 6), and Chapter 8, System Types and Requirements (formerly Chapter 7), are two of the few chapters that were renumbered and moved intact. The former Chapter 9, Hanging, Bracing and Restraint of System Piping, was divided into two chapters based on subject matter: Chapter 17, Installation Requirements for Hanging and Support of System Piping, and Chapter 18, Installation Requirements for Seismic Protection.

As indicated, Chapter 8 in the 2016 edition had become the resting place for a great deal of information that was not well organized. Users looking for installation requirements or combustible concealed space requirements were forced to wade through a lot of information to find what they were looking for. The chapter was divided into several new chapters with an improved and more logical organization. For example, the new Chapter 9, Sprinkler Location Requirements, contains much of the introductory information contained in the former Chapter 8, while Chapters 10 through 15 contain installation requirements for individual types of sprinklers: Chapter 10 covers installation requirements for standard upright, pendent, and sidewall sprinklers; Chapter 11 covers installation requirements for extended-coverage upright, pendent, and sidewall spray sprinklers, and so on. Chapter 12 covers residential sprinklers, Chapter 13 covers CMSA sprinklers, Chapter 14 addresses ESFR sprinklers, and the new Chapter 15 covers installation requirements for special sprinklers.

Chapter 16, Installation of Piping, Valves and Appurtenances, is a compilation of former Chapters 6 and 8. Similarly, Chapter 19, Design Approaches, includes all or parts of Chapters 4, 8, 11, and 23 from the previous edition of NFPA 13.

CONFERENCE SESSIONS

NFPA 13–2019, *Standard for the Installation of Sprinkler Systems:* A New Format for the Standard That Started It All
Tuesday, June 12,
9:30–10:30 a.m.
Russell Leavitt, Telgian Corp.

NFPA 13–2019, *Standard for the Installation of Sprinkler Systems:* Changes
Tuesday, June 12,
3:30–4:30 p.m.
Robert Caputo, Fire & Life Safety America

NFPA 13–2019: A Case Study for the Reorganization of a Major NFPA Standard
Wednesday, June 13, 2–3 p.m.
Russell Leavitt, Telgian Corp.; Kenneth Linder, Swiss Re; Chad Duffy and David Hague, NFPA

13

The new Chapter 20, General Requirements for Storage, is a renumbering exercise of the former Chapter 12, while the rest of the storage chapters (Chapters 21–25) have been completely revamped and are now organized by protection method: Chapter 21, Protection of High Piled Storage Using Control Mode Density Area (CMDA) Sprinklers; Chapter 22, CMSA Requirements for Storage Applications; Chapter 23, ESFR Sprinklers; Chapter 24, Alternative Designs; and Chapter 25, Protection of Rack Storage Using In-Rack Sprinklers, which has been reorganized into a rack storage chapter. This approach to determining protection of storage should make this task much easier and finding information much more efficient.

The remainder of the standard includes Chapter 26, Special Occupancy Requirements (formerly Chapter 22); Chapter 27, Plans and Calculations (formerly Chapter 23); Chapter 28, Systems Acceptance (formerly Chapter 25); Chapter 29, Existing System Modifications (including portions of the former Chapters 6, 8, and 27); Chapter 30, Marine Systems (formerly Chapter 26); and Chapter 31, System Inspection, Testing and Maintenance (formerly Chapter 27).

Information is now clearly separated by subject matter—sprinkler technology, storage method, commodity, and so on—and is organized in the order the information is needed.

Stakeholders ranging from users of the standard, technical committee members, and NFPA staffers expressed concern over being able to find familiar information in the reorganized standard. If a user wanted to know where the requirements for sprinklers in electrical equipment rooms resided (formerly Section 8.15.11), where would they look? We prepared a road map for the new edition similar to the one created for the 1999 edition, when the storage information was added to NFPA 13. It remains uncertain where this information will be provided and in what format, but we are working to create useful guidance so that every section from the 2016 edition can be found and is accounted for in the 2019 edition. The technical committee and task group are confident that with regular use of the new NFPA 13, users will be able to find the information they need much more easily and in a more understandable way.

DAVID HAGUE *is principal fire protection engineer at NFPA.*

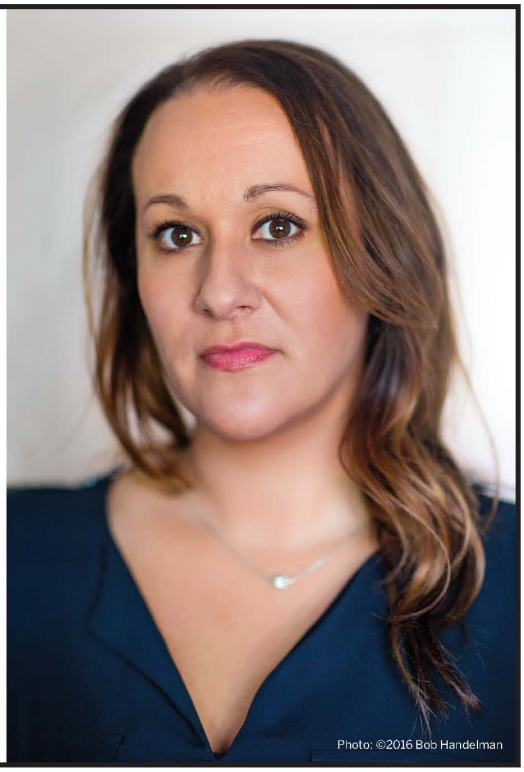
"I now feel more comfortable living in this home. If my kids are home alone and something happens again, fire sprinklers would give them time to get out."

— Michelle Allyn, lost her home to fire and rebuilt with fire sprinklers

Every home fire has a story.
Learn how these tragedies have altered the lives of fire survivors and how fire sprinklers may have altered the outcomes.

FireSprinklerInitiative.org/Faces

NFPA | FACES OF FIRE
A CAMPAIGN OF NFPA'S FIRE SPRINKLER INITIATIVE


Photo: ©2016 Bob Handelman

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UNIT 2: WATER SUPPLIES

TERMINAL OBJECTIVE

The students will be able to:

2.1 Evaluate residential sprinkler system water supply components for compliance with national standards.

ENABLING OBJECTIVES

The students will be able to:

2.1 Differentiate water supply configuration options.

2.2 Calculate the minimum water supply requirement for a known flow sprinkler.

2.3 Calculate the minimum static water supply requirement, given a known flow from four sprinklers.

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FEMA

U.S. Fire Administration

UNIT 2:
WATER SUPPLIES

Slide 2-1

TERMINAL OBJECTIVE

Evaluate residential sprinkler system water supply components for compliance with national standards.

Slide 2-2

ENABLING OBJECTIVES

- Differentiate water supply configuration options.
- Calculate the minimum water supply requirement for a known flow sprinkler.
- Calculate the minimum static water supply requirement, given a known flow from four sprinklers.

Slide 2-3

I. WATER SUPPLIES

WATER SUPPLY OPTIONS

- Should be from an automatic supply.
- Non-pressurized tank with electric pump.
- Pressure tank.
  - Compressed air or inert gas.

Slide 2-4

A. Every automatic sprinkler system needs at least one automatic water supply.

1. The supply shall be capable of delivering the minimum amount of water required to operate the system for the minimum amount of time specified in the standards.

2. In all cases, the water source shall be reliable.

WATER SUPPLY OPTIONS (cont'd)

- Municipal authority, private provider, or well of adequate capacity.
  - Service size.
  - Dedicated supply.
  - Combined supply.
  - Multipurpose system.



Slide 2-5

B. The most common water supply arrangements for residential sprinkler systems include:

1. Supply that comes from a municipal-type water system.

a. National Fire Protection Association (NFPA) 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, and 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, offer options for connection to a municipal-type water system.

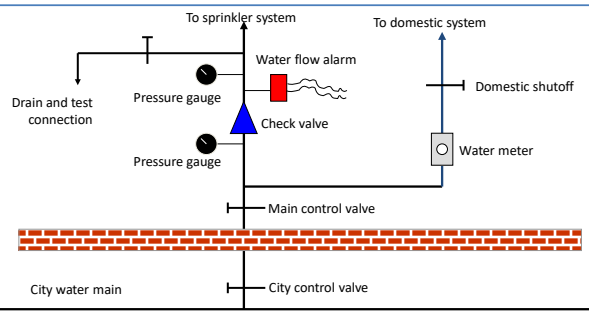
KNOWLEDGE CHECK

Every automatic sprinkler system needs at least how many automatic water supplies?

A. One.
B. Two.
C. Three.
D. Four.

Slide 2-6

PREFERRED MUNICIPAL METHOD



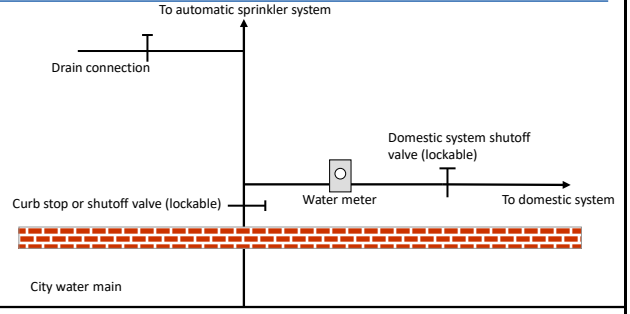
Plan view

Source: National Fire Protection Association (NFPA) 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*/13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes.*

Slide 2-7

b. International Residential Code (IRC) P2904 is generally intended to use municipal-type water systems in combination with domestic demand, but does allow other supply options, including wells and storage tanks.

MINIMUM REQUIRED

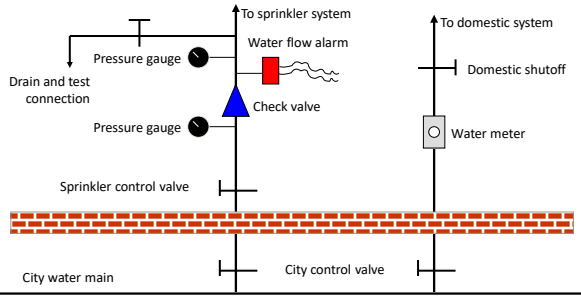


Plan view

Source: NFPA 13R/13D

Slide 2-8

ALTERNATE NO. 1

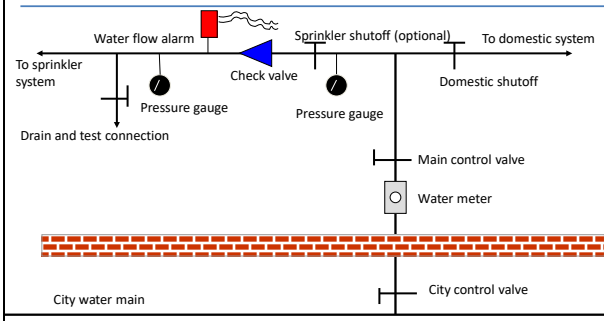


Plan view

Source: NFPA 13R/13D

Slide 2-9

ALTERNATE NO. 2



Plan view

Source: NFPA 13R/13D

Slide 2-10

NON-PRESSURIZED TANK

- Requires a pump.
- Plastic or metal container.
  - 260 to 300 gallons.
  - Can fit through standard door.



Slide 2-11

2. Stored supply that comes from a non-pressurized water storage tank.

   a. This may include a gravity-fed elevated tank or suction tank.

b. When considering the installation of an indoor tank, remember to evaluate the potential load it is adding to the structure.

NON-PRESSURIZED TANK (cont'd)

- Point load considerations.
  - -- 8.35 pounds per gallon.
  - -- 62.4 pounds per cubic foot.
- Weight of tank.



Slide 2-12

- Water weighs 8.35 pounds per gallon.
- A filled 300-gallon tank adds about 2,500 pounds to the floor where it is sitting.
- Tank weight (tare) should be included, about 75 to 80 pounds.

ELECTRIC PUMP FOR NFPA 13D/IRC P2904

- Sized to deliver required flow at needed pressure.
- Separate standby or emergency power not required.
  - Fire protection listing not required.
  - Electrical listing required.



Slide 2-13

3. For NFPA 13D systems, where a stand-alone tank and pump is the source of stored water supply for a fire sprinkler system, but is not part of the domestic water system:

   a. The tank shall contain the minimum capacity needed to supply the system.

b. A method for refilling the tank shall be piped to the tank. This can be from the domestic service.

c. A method of seeing the water level in the tank without having to open it shall be provided.

ELECTRIC PUMP FOR NFPA 13D

- 240-volt (V) normal circuit.
- Elevated above floor no less than 1.5 inches.



Slide 2-14

d. If a water flow alarm is provided, a test connection shall be provided downstream of the pump that creates a flow of water equal to the smallest sprinkler on the system. The connection shall return water to the tank.

e. Pump motors using alternating current (AC) power shall be connected to a 240-volt (V) normal circuit. Standby, secondary or backup power supplies for the pump are **not** required.

ELECTRIC PUMP FOR NFPA 13R



Slide 2-15

f. Any means for disconnecting the pump shall be approved by the code official.

- The pump may not sit directly on the floor.

- Pump is Underwriters Laboratories (UL)-listed for electrical safety, not fire protection service.

g. IRC P2904 does not address pump design and installation criteria for fire protection systems, but it does mention that performance testing is required if pumps are installed.

ELECTRIC PUMP FOR NFPA 13R (cont'd)

- Underwriters Laboratories (UL)-listed for fire protection.
- UL-listed pump controller.
- Pressure maintenance pump.
- Pump test header.
- Where a fire pump is installed, the fire pump shall be installed in accordance with NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*.

Slide 2-16

h. For systems designed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and 13R, the fire pump assembly shall meet the requirements of NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection.*

- Fire pumps, controllers and drivers shall be listed for fire protection service and approved.

PRESSURE TANK

- Pressure vessel under constant pressure.
- Atmospheric vessel with pressure provided by compressed air or inert gas when sprinkler system operates.



Slide 2-17

4. Stored supply that comes from a pressurized water storage tank. If pressurized, it shall meet the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC).

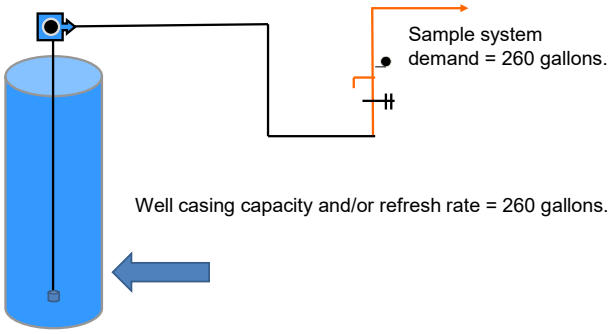
KNOWLEDGE CHECK

What tank uses an electric pump?

A. Non-pressurized tank.
B. Pressure tank.

Slide 2-18

PRIVATE WELL (NFPA 13D)

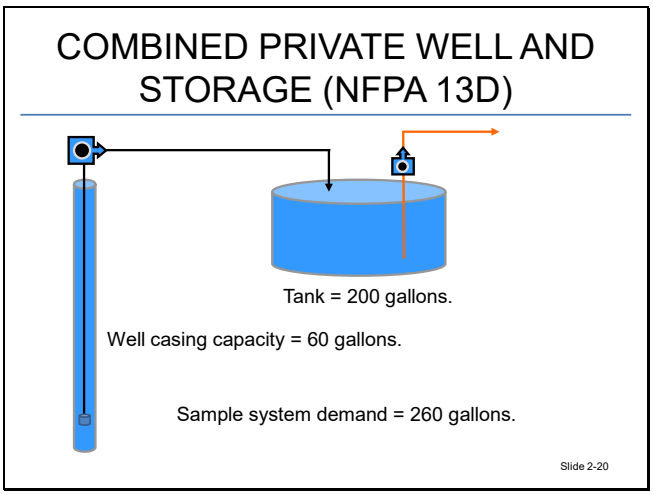


Slide 2-19

5. Supply that comes from a private well casing (NFPA 13D).

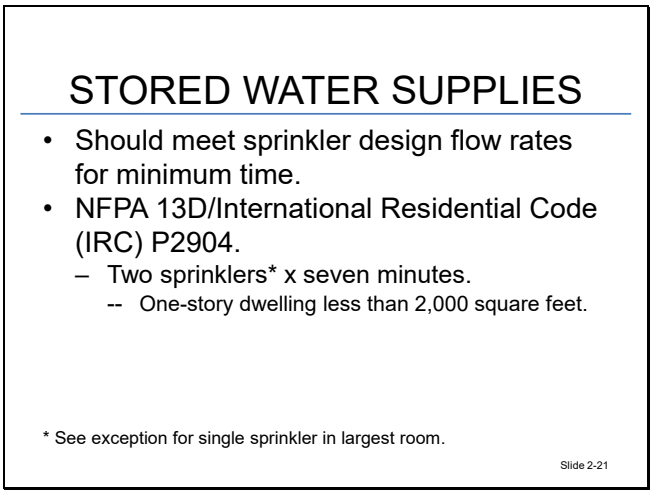
   a. A well system shall contain a pump of sufficient capacity and pressure to support the sprinkler system demand.

   b. If the well casing is large enough, or the combined well casing and refresh rate can provide the required flow, no additional storage is required.



c. If the well supply alone cannot support the system, it can employ a combination of water in the well (including refill rate) plus the water in a holding tank if the tank supplies the sprinkler system.

d. Standby, secondary or backup power supplies for the well and tank pump(s) are **not** required.



6. The minimum stored water supply requirement for an NFPA 13D and IRC P2904 design is based on a specific number of sprinklers flowing, called the "design sprinklers."

a. Two sprinklers for seven minutes in a one-story, single-family dwelling unit less than 2,000 square feet.

STORED WATER SUPPLIES (cont'd)

- NFPA 13D/IRC P2904.
  - Two sprinklers* x 10 minutes.
    - -- Two or more story dwelling, or more than 2,000 square feet.
- NFPA 13R.
  - Four sprinklers x 30 minutes.
  - Up to four sprinklers in one compartment.

* See exception for single sprinkler in largest room.

Slide 2-22

b. Two sprinklers for 10 minutes for a dwelling unit two or more stories, or more than 2,000 square feet.

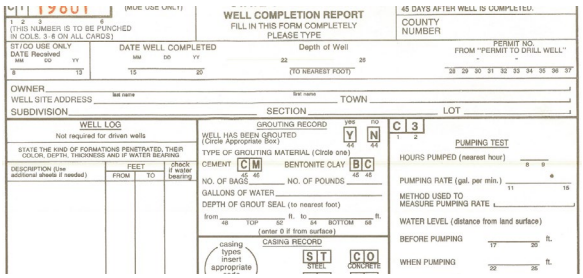
c. Exception: one sprinkler (if the largest room(s) has only a single sprinkler).

d. The minimum stored water supply requirement for an NFPA 13R design is based on a specific number of sprinklers flowing — up to four sprinklers for 30 minutes.

e. The minimum stored water supply requirement for an NFPA 13 design is based on the required design density for no less than 30 minutes.

WELL DRILLER'S REPORT

Maryland Example


WELL COMPLETION REPORT
FILL IN THIS FORM COMPLETELY
PLEASE TYPE
COUNTY NUMBER
PERMIT NO. FROM "PERMIT TO DRILL WELL"
DATE WELL COMPLETED
Depth of Well (TO NEAREST FOOT)
OWNER
WELL SITE ADDRESS
TOWN
SUBDIVISION
SECTION
LOT
WELL LOG
Not required for driven wells
STATE THE KIND OF FORMATIONS PENETRATED, THEIR COLOR, DEPTH, THICKNESS AND IF WATER BEARING
DESCRIPTION (Use additional sheets if needed)
FEET FROM TO
check if water bearing
GROUTING RECORD
WELL HAS BEEN GROUTED (Circle Appropriate Box)
TYPE OF GROUTING MATERIAL (Circle one)
CEMENT
BENTONITE CLAY
NO. OF BAGS
NO. OF POUNDS
GALLONS OF WATER
DEPTH OF GROUT SEAL (to nearest foot)
from ft. to ft.
(enter 0 if from surface)
CASING RECORD
casing types insert appropriate
STEEL
CONCRETE
PUMPING TEST
HOURS PUMPED (nearest hour)
PUMPING RATE (gal. per min.)
METHOD USED TO MEASURE PUMPING RATE
WATER LEVEL (distance from land surface)
BEFORE PUMPING ft.
WHEN PUMPING ft.

Slide 2-23

KNOWLEDGE CHECK

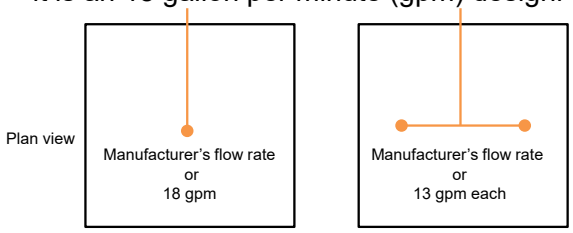
The minimum stored water supply requirement for an NFPA 13R design is based on up to how many sprinklers for 30 minutes?

A. One.
B. Two.
C. Three.
D. Four.

Slide 2-24

SINGLE SPRINKLER DESIGN

When a single sprinkler can protect the largest room, and generic flow rate is used, it is an 18 gallon per minute (gpm) design.



Slide 2-25

DESIGN FLOW RATES/STORED SUPPLY

- Specified in manufacturer's catalog literature.
  - If not specified, assume minimum 13 gpm.

Slide 2-26

7. Combined domestic and sprinkler supplies.

a. Per NFPA 13D and IRC P2904, in systems that supply **more than one dwelling unit,** an additional 5 gallons per minute (gpm) shall be added to the system demand to accommodate domestic use, unless there is a device that automatically shuts off water to the domestic system when the sprinkler flows.

DESIGN FLOW RATES/STORED SUPPLY (cont'd)

- Example:
  - Generic sprinkler designed to flow 13 gpm.

13 gpm x 2 sprinklers x 7 minutes = 182 gallons
13 gpm x 2 sprinklers x 10 minutes = 260 gallons
13 gpm x 4 sprinklers x 30 minutes = 1,560 gallons

Slide 2-27

DESIGN FLOW RATES/STORED SUPPLY (cont'd)

- NFPA 13D/IRC P2904.
  - Add 5 gpm if system serves more than one dwelling unit.
  - Example:
    - Generic sprinkler designed to flow 13 gpm.

13 gpm x 2 sprinklers = 26 gpm
26 gpm + 5 gpm = 31 gpm
31 gpm x 10 minutes = 310 gallons

Slide 2-28

COMBINED DOMESTIC/FIRE

- NFPA 13R.
- Use fixture count table unless domestic supply is automatically shut off during sprinkler operation.

Slide 2-29

b. In NFPA 13R design systems that employ combined sprinkler and domestic demand (unless there is a device that automatically shuts off water to the domestic system when sprinkler flows), additional supply shall be included.

- The standard does not provide guidance on rounding up, rounding down or interpolating values that fall between those specified in the tables.

KNOWLEDGE CHECK

What is the minimum design flow rate to assume if it is not specified in the manufacturer's catalog literature?

A. 10 gpm.
B. 11 gpm.
C. 12 gpm.
D. 13 gpm.

Slide 2-30

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ACTIVITY 2.1

Calculating Minimum Water Supply Requirements — Residential

Purpose

Determine the minimum required water supply for various residential sprinkler configurations.

Direction

Given a series of scenario-type questions describing an occupancy and generic sprinkler flows, work in your table groups to calculate the minimum required water supply needed to support each scenario.

Scenarios

1. A ranch-style, single-family dwelling unit is one story in height and is 3,200 square feet. It has been determined that each sprinkler flows 9 gpm. What is the total stored water supply required for the sprinkler system for this dwelling unit?

2. A two-story, single-family dwelling on a small lot in an urban neighborhood has a first-floor footprint of 800 square feet, and the second floor measures the same. It has been determined that each sprinkler flows 16 gpm. What is the total stored water supply required for the sprinkler system for this dwelling unit?

3. A three-story, 12-unit apartment building is constructed of wood-frame walls and has poured-in-place concrete floors separating the stories. The entire building measures 23,000 square feet. It has been determined that each sprinkler flows 16 gpm. What is the total stored water supply required for the sprinkler system for this apartment?

4. A three-story, 12-unit townhouse building consists of 12 side-by-side units. The building is constructed of steel-frame walls and has wood floor systems to absorb sound. The entire building measures 36,000 square feet. It has been determined that each sprinkler flows 14.3 gpm. What is the total stored water supply for the sprinkler system required for this structure?

5. A one-story, single-family dwelling in an exclusive part of town measures 18,000 square feet. It has been determined that two sprinklers flow a combined 21.2 gpm. What is the total stored water supply for the sprinkler system required for this structure?

6. A rural, two-story duplex uses a stored water tank and electric pump to provide fire protection. What is the required voltage needed to supply the pump for the sprinkler system?

7. A suburban, 6,200 square foot duplex uses a combined domestic and sprinkler supply. It has been determined that two sprinklers flow a combined 23.7 gpm. For what total flow in gpm shall the combined domestic and sprinkler be designed?

8. A three-story, multifamily apartment building is sprinklered in accordance with NFPA 13R. The building uses a combined domestic and sprinkler supply. It has been determined that four sprinklers flow a combined 57.2 gpm.

   The building has six bathroom groups with flush tanks, six dishwashers, six kitchen sinks and a community washing machine capable of handling 16 pounds. For what total flow in gpm shall the combined domestic and sprinkler be designed? (See Appendix A: Overall Plan for the Purple House Residential Sprinkler System of this unit for fixture count load value and demand tables information.)

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ACTIVITY 2.2

Calculating Minimum Water Supply Requirements

Purpose

Determine the minimum required water supply for a specific project.

Directions

1. Using the Purple House example in Unit 1: Design and Installation Standards, Appendix A, work in your table groups to determine the minimum tank size needed to support the sprinkler system. **Note:** For the purpose of this exercise, ignore the values shown on the plans and use the following values.

2. The sprinklers used in this project deliver 13 gpm at 7 pounds per square inch (psi).

3. What minimum size tank is required for this project?

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QUICK COMPARISON

	NFPA 13	NFPA 13R	NFPA 13D/IRC P2904
Scope	All occupancies	Group R to four stories and 60 feet in height	One- and two-family and townhouses
Coverage	Entire building	Occupied spaces	Occupied spaces
Sprinkler design	Control mode, pipe schedule, hydraulic design, minimum 0.1 gpm/square foot	Life-safety control mode, four-head design, or 0.05 gpm/square foot	Life-safety control mode, two-head design, or 0.05 gpm/square foot
Sprinklers	All approved types, residential in dwelling unit, and adjacent corridor	Residential in dwelling unit and adjacent corridor, other approved types elsewhere	Residential in dwelling unit, other approved types elsewhere
Water demand	System, plus 100 to 500 gpm	± 52 gpm	± 26 gpm
Duration			
Fire Department Connection (FDC)			

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II. SUMMARY

FEMA U.S. Fire Administration

SUMMARY

- Remember the difference between flow rate and total supply.
- Know the reliable water supply required.
  - Municipal type.
  - Well casing with/without tank.
  - Stored.
    - -- Non-pressurized.
    - -- Pressurized.

Slide 2-34

FEMA U.S. Fire Administration

SUMMARY (cont'd)

- Design flow rates are usually specified in the manufacturer's catalog literature.
- For NFPA 13R, use the fixture count table.
- For NFPA 13D and IRC P2904, add 5 gpm if the system serves more than one dwelling unit.

Slide 2-35

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APPENDIX A

FIXTURE LOAD VALUES AND TOTAL ESTIMATED DEMAND TABLES

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Fixture Load Values from National Fire Protection Association 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*

Facility Type	Unit
Private Facilities (those within individual dwelling units)	
Bathroom group with flush **tank** (including lavatory, water closet and bathtub with shower)	6
Bathroom group with flush **valve**	8
Bathtub	2
Dishwasher	1
Kitchen sink	2
Laundry trays (fixture supplied with cold and hot water and a drain)	3
Lavatory (fixed bowl for washing with supply and drain)	1
Shower stall	2
Washing machine	2
Water closet with flush **valve** (toilet bowl and its accessories)	6
Water closet with flush **tank**	3
Public Facilities	
Bathtub	4
Drinking fountain	0
Kitchen sink	4
Lavatory	2
Service sink	3
Shower head	4
Urinal with 1-inch flush **valve**	10
Urinal with ¾-inch flush **valve**	5
Urinal with flush **tank**	3
Washing machine (8-pound capacity)	3
Washing machine (16-pound capacity)	4
Water closet with flush **valve**	10
Water closet with flush **tank**	5

Excerpted from NFPA 13R, Table A.9.6(a), Copyright 2016, National Fire Protection Association.

Remember to use the table on the following page to convert "units" to gallons per minute (gpm).

Total Estimated Domestic Demand

	Total Demand	
Total Fixture Load Units	**For Systems with Predominately Flush Tanks (gpm)**	**For Systems with Predominately Flush Valves (gpm)**
1	3	--
2	5	--
5	10	15
10	15	25
20	20	35
35	25	45
50	30	50
70	35	60
100	45	70
150	55	80
200	65	90
250	75	100
350	100	125
500	125	150
750	175	175
1,000	200	200
1,500	275	275
2,000	325	325
3,500	500	500

Excerpted from NFPA 13R, Table A.9.6(b), Copyright 2016, National Fire Protection Association.

APPENDIX B

WATER WELL DETAILS

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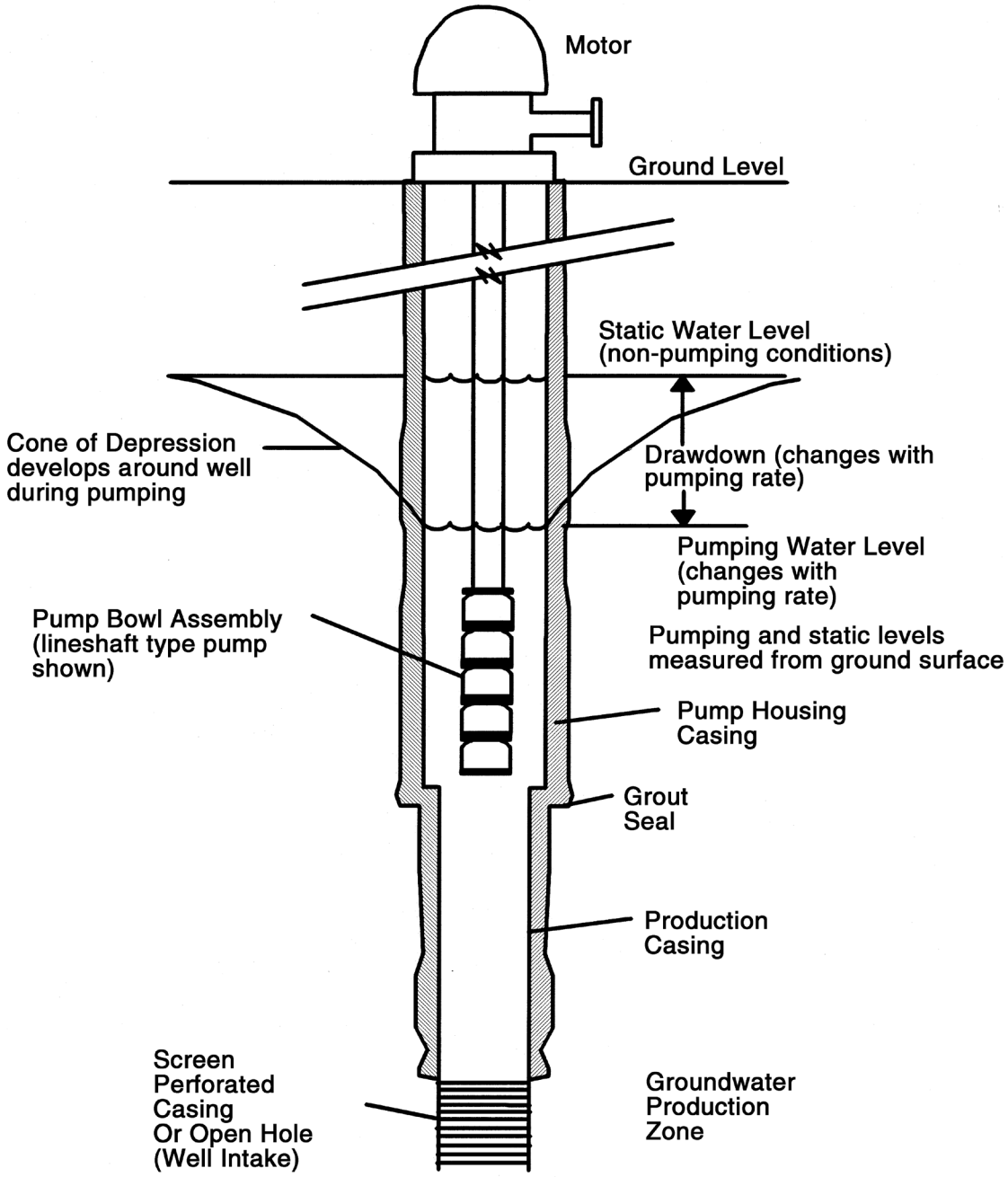


Figure 3

Source: ASHRAE Transactions, Vol. 107, Pt. 2., Copyright 2001, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Used with permission.

Figure 3 is from an article published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., and is used here to explain how wells can be used as residential sprinkler water sources.

In any well, under non-pumping conditions, the level at which the water resides in the well is known as the **static water level.** When the pump is started, the water level will drop to a new level known as the **pumping level,** and this level is a function of the pumping rate. The difference between the static water level and the pumping level is referred to as the **drawdown.**

Dividing the pumping rate by the drawdown yields a value known as the specific capacity with units of gallons per minute (gpm) per foot. This value provides a rough indication of the aquifer/ well capacity to produce water. The drawdown is the manifestation of the "cone of depression," which forms around the well in response to pumping.

The lower portion of the well in the production zone may be completed with only a borehole (in rock formations), a screen, or a screen and an artificial filter (gravel pack), depending on the nature of the aquifer materials. Casing is placed in the well to support the borehole and prevent collapse to accommodate the installation of a pump or to facilitate the placement of a seal. The diameter of the innermost well casing, known as the **pump housing casing,** is primarily a function of the size of the pump to be installed.

The gross volume of the pump housing casing can be computed by the formula:

$$V = (\pi r^2 h)*7.48$$

Where:

V = volume in gallons.
π = pi (constant 3.1415).
r = radius of the pump housing casing.
h = pump housing casing height (depth).

Displacement by the pump bowl assembly and shaft should be considered as reducing the overall volume.

However, the amount of water that can be pumped out of a well at any given time is limited by the size of the **static head** and the well recovery or well **flow rate,** and of course by the **pump rate,** the gpm that the pump itself can or is set to deliver.

The capacity of the well pump casing alone is not the only factor to be considered. People sometimes confuse things by describing what we call the well "flow rate" as the "water quantity" available from a well. They are different.

You could have a great well waterflow rate — say 20 gpm — but if the water will only run at that rate for five minutes before you run out, the well has a very poor water quantity (5 minutes x 20 gpm = 100 gallons of water), and it is not a satisfactory well for fire protection.

A true well flow rate is not what we can measure in the building over five minutes; it is the ability of a well to deliver a sustained waterflow rate over a longer period, usually measured over 24 hours. For fire protection purposes, if relying solely on the well's performance, the flow rate shall be sustained for seven, 10 or 30 minutes, depending on the NFPA sprinkler design standard that is being used.

If the well is not capable of supplying the **flow rate** or **required amount** on its own, a combination system can be employed, where the flow rate and quantity from the well are added to a storage tank inside the building, and the combined capacities are used to meet the water supply requirements.

For example, if a well can provide a sustained output of 8 gpm for 20 minutes, the total output is 160 gallons. This quantity is not adequate to supply most currently designed sprinkler systems.

If the sprinkler system needed 320 total gallons at a flow rate of 32 gpm, this sample well could be combined with a 160-gallon storage tank and a separate booster pump to achieve the fire protection demand.

	Volume
Well capacity	160 gallons
Storage tank	160 gallons
Combined	320 gallons

The booster pump would have to be sized to deliver at least 32* gpm at a pressure needed to overcome the influence of friction in pipe and elevation differences.

(*Additional flow is required to fill the sprinkler system distribution pipe between the pump and the flowing sprinklers, so the actual pump output may be in the area of 35 gpm or more depending upon the size of the sprinkler system.)

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APPENDIX C

WELL DRILLER'S REPORT EXAMPLE

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C 1 19801 — SEQUENCE NO. (MDE USE ONLY)
(THIS NUMBER IS TO BE PUNCHED IN COLS. 3-8 ON ALL CARDS)

STATE OF MARYLAND
WELL COMPLETION REPORT
FILL IN THIS FORM COMPLETELY
PLEASE TYPE

THIS REPORT MUST BE SUBMITTED WITHIN 45 DAYS AFTER WELL IS COMPLETED.
COUNTY NUMBER

ST/CO USE ONLY
DATE Received MM DD YY

DATE WELL COMPLETED MM DD YY

Depth of Well (TO NEAREST FOOT)

PERMIT NO. FROM "PERMIT TO DRILL WELL"

OWNER (last name, first name)
WELL SITE ADDRESS ____ TOWN ____
SUBDIVISION ____ SECTION ____ LOT ____

WELL LOG
Not required for driven wells

STATE THE KIND OF FORMATIONS PENETRATED, THEIR COLOR, DEPTH, THICKNESS AND IF WATER BEARING

DESCRIPTION (Use additional sheets if needed)	FEET FROM	FEET TO	check if water bearing

NUMBER OF UNSUCCESSFUL WELLS: ____

WELL HYDROFRACTURED yes Y no N

CIRCLE APPROPRIATE LETTER
A — A WELL WAS ABANDONED AND SEALED WHEN THIS WELL WAS COMPLETED
E — ELECTRIC LOG OBTAINED
P — TEST WELL CONVERTED TO PRODUCTION WELL

I HEREBY CERTIFY THAT THIS WELL HAS BEEN CONSTRUCTED IN ACCORDANCE WITH COMAR 26.04.04 "WELL CONSTRUCTION" AND IN CONFORMANCE WITH ALL CONDITIONS STATED IN THE ABOVE CAPTIONED PERMIT, AND THAT THE INFORMATION PRESENTED HEREIN IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

DRILLERS LIC. NO.: M __ D __ __ __
DRILLERS SIGNATURE
(MUST MATCH SIGNATURE ON APPLICATION)
LIC. NO.: __ __ D __ __ __

SITE SUPERVISOR (sign, of driller or journeyman responsible for sitework if different from permittee)

GROUTING RECORD
WELL HAS BEEN GROUTED (Circle Appropriate Box) yes Y (44) no N (44)
TYPE OF GROUTING MATERIAL (Circle one)
CEMENT CM (45 46) BENTONITE CLAY BC (45 46)
NO. OF BAGS ____ NO. OF POUNDS ____
GALLONS OF WATER ____
DEPTH OF GROUT SEAL (to nearest foot)
from ____ (48 TOP 52) ft. to ____ (54 BOTTOM 58) ft.
(enter 0 if from surface)

CASING RECORD
casing types insert appropriate code below
ST STEEL; CO CONCRETE; PL PLASTIC; OT OTHER

MAIN CASING TYPE (60 61) — Nominal diameter top (main) casing (nearest inch) (63 64) — Total depth of main casing (nearest foot) (66 70)

EACH CASING — OTHER CASING (if used): diameter inch; depth (feet) from; to

SCREEN RECORD
screen type or open hole — insert appropriate code below
ST STEEL; BR BRASS, BRONZE; HO OPEN HOLE; PL PLASTIC; OT OTHER

C 2 — DEPTH (nearest ft.)
EACH SCREEN
1. (8 9) (11 15) (17 21)
2. (23 24) (26 30) (32 36)
3. (38 39) (41 45) (47 51)

SLOT SIZE 1 ____ 2 ____ 3 ____
DIAMETER OF SCREEN ____ (56 60) (NEAREST INCH)
from ____ to ____
GRAVEL PACK IF WELL DRILLED WAS FLOWING WELL INSERT F IN BOX 68 (68)

MDE USE ONLY
(NOT TO BE FILLED IN BY DRILLER)
T (70) (E.R.O.S.) (72) W Q (74 75 76)
TELESCOPE CASING; LOG INDICATOR; OTHER DATA

C 3
PUMPING TEST
HOURS PUMPED (nearest hour) (8 9)
PUMPING RATE (gal. per min.) (11 15)
METHOD USED TO MEASURE PUMPING RATE ____
WATER LEVEL (distance from land surface)
BEFORE PUMPING ____ (17 20) ft.
WHEN PUMPING ____ (22 25) ft.
TYPE OF PUMP USED (for test)
A (27) air; P (27) piston; T (27) turbine; C (27) centrifugal; R (27) rotary; O (27) other (describe below); J (27) jet; S (27) submersible

PUMP INSTALLED
DRILLER INSTALLED PUMP (CIRCLE) (YES or NO) YES NO
IF DRILLER INSTALLS PUMP, THIS SECTION MUST BE COMPLETED FOR ALL WELLS.
TYPE OF PUMP INSTALLED PLACE (A,C,J,P,R,S,T,O) IN BOX 29. (29)
CAPACITY: GALLONS PER MINUTE (to nearest gallon) (31 35)
PUMP HORSE POWER (37 41)
PUMP COLUMN LENGTH (nearest ft.) (43 47)
CASING HEIGHT (circle appropriate box and enter casing height)
+ (49) above; – (49) below LAND SURFACE (nearest foot) (50 51)

LATITUDE 3 _ . _ _ _ _ _ _
LONGITUDE 7 _ . _ _ _ _ _ _
(DEFAULT COORD. WGS 84)
NOTES:

MDE/WMA/PER.071

ORIGINAL

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UNIT 3
PIPE, VALVES AND TRIM

TERMINAL OBJECTIVE

The students will be able to:

3.1 Evaluate the residential sprinkler system pipe, valves and trim components and the design for compliance with national standards.

ENABLING OBJECTIVES

The students will be able to:

3.1 Identify the location of components in a residential sprinkler system.

3.2 Differentiate types of unlisted and listed pipe.

3.3 Evaluate head-loss values caused by domestic water meters from a sample flow characteristic curve.

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FEMA

U.S. Fire Administration

UNIT 3:
PIPE, VALVES AND TRIM

Slide 3-1

TERMINAL OBJECTIVE

Evaluate the residential sprinkler system pipe, valves and trim components and the design for compliance with national standards.

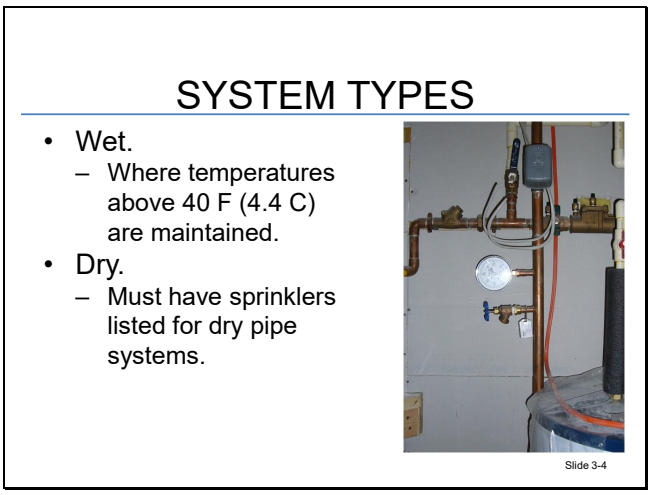
Slide 3-2

ENABLING OBJECTIVES

- Identify the location of components in a residential sprinkler system.
- Differentiate types of unlisted and listed pipe.
- Evaluate head-loss values caused by domestic water meters from a sample flow characteristic curve.

Slide 3-3

I. SPRINKLER SYSTEM TYPES



Three major categories of sprinkler system types are recognized by national residential design and installation standards.

A. Wet pipe: a system employing automatic sprinklers connected to a piping system containing water so that water will discharge immediately from sprinklers opened by heat from a fire.

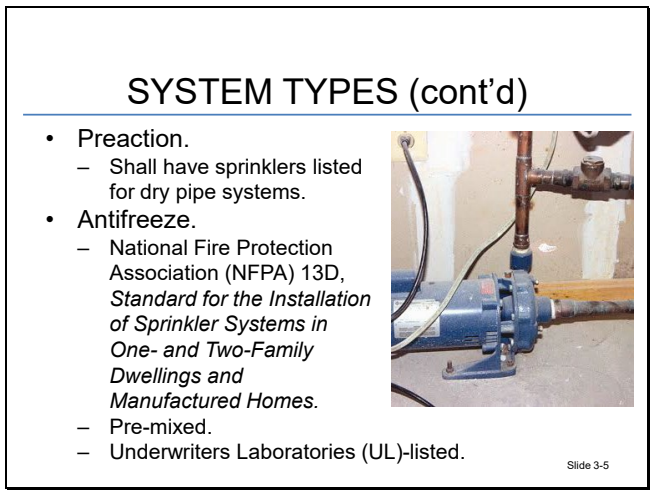
1. Required design where sprinkler pipe can be maintained at 40 F (4.4 C) or greater.

2. For installations where pipe cannot be maintained at 40 F (4.4 C) or greater, the following options are available.

B. Dry pipe: a system employing automatic sprinklers that are attached to a piping system that has air or nitrogen under pressure, the release of which permits the water to open a valve known as a dry pipe valve, and then water fills the pipe and flows out of the open sprinkler.

1. Sprinklers on a dry pipe must be specifically listed for dry pipe use (e.g., Tyco 2234 Upright/Pendent or 2334 Horizontal Sidewall). Its use must be approved by the code official.

2. Dry pipe systems must be capable of delivering water to the system's most remote sprinkler within 15 seconds of sprinkler operation.



C. Preaction: a system employing automatic sprinklers that are attached to a piping system that has air that might or might not be under pressure, with a supplemental detection system (smoke) installed in the same areas as the sprinklers.

There are three acceptable preaction operating modes.

1. A single interlock system, which admits water to sprinkler piping upon operation of detection devices.

2. A noninterlock system, which admits water to sprinkler piping upon operation of detection devices or automatic sprinklers.

3. A double interlock system, which admits water to sprinkler piping upon operation of both detection devices and automatic sprinklers.

   Double interlock preaction systems shall be capable of delivering water to the system's most remote sprinkler within 15 seconds of sprinkler operation.

D. Antifreeze: a wet pipe system containing a chemical solution intended to prevent water from freezing.

1. Used as an option where ambient temperature may be less than 40 F (4.4 C), making them an option for cold environments, especially in attics or small, unheated spaces.

   Other solutions, such as tenting insulation over the pipes as illustrated in National Fire Protection Association (NFPA) 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, and 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, installing pipe in warm spaces, using listed heat-tracing equipment, or the use of dry pipe or preaction systems are recommended by the NFPA.

2. When using post-chlorinated polyvinyl chloride (CPVC) pipe, only food-grade glycerine (chemically pure or United States Pharmacopoeia 96.5%) may be used in antifreeze solution.

   a. Diethylene, ethylene and propylene glycols are **specifically prohibited** by the pipe manufacturer due to chemical reactions that may cause the pipe to leak.

   b. Propylene glycol may be used in copper or steel pipe systems.

3. Antifreeze systems connected to municipal-type water supplies must comply with any local or state health requirements.

   This generally includes one or more cross-contamination control devices, also known as backflow preventers.

4. If the antifreeze portion is not isolated from the wet pipe system by cross-contamination prevention, it must have a drop loop or U-loop in accordance with NFPA 13D.

5. Antifreeze solutions must be pre-mixed at a factory.

6. The maximum allowable concentration of glycerine for a new system is 48% by volume (50% in existing systems), and the maximum allowable concentration of propylene glycol for a new system is 38% by volume (40% in existing systems).

7. All factory pre-mixed antifreeze solutions used in NFPA 13, *Standard for the Installation of Sprinkler Systems*, and 13R systems shall be provided with a certificate indicating the type of antifreeze, the concentration and the freezing point.

8. For annual antifreeze testing and replacement recommendations, refer to NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

II. RESIDENTIAL SPRINKLER SYSTEM COMPONENTS

SPRINKLER SYSTEM COMPONENTS OVERVIEW

- Valves.
- Alarm.
- Pipe.
- Water meters.
- Hangers.



Slide 3-6

A. Residential sprinkler systems require very few components to control and deliver water. Some of this is by design.

1. Reduces the number of sprinkler components in the system, thereby reducing the installation and maintenance costs.

2. Reduces the number of potential "failure points," such as inadvertently closed valves.

CONTROL VALVES

- Indicating and non-indicating.
  - For combined domestic/fire.
  - Control valve must shut off both.



Slide 3-7

B. Water supply control valves. There are two predominant types of control valves used in fire protection system design.

1. Indicating valves that enable one to determine their open/closed status by visual check. These include:

   a. Outside stem and yoke (OS&Y).

b. Post indicator valve (PIV).

- Not commonly used on small residential systems.

c. Wall indicator valve (WIV).

- Not commonly used on small residential systems.

d. Quarter-turn valve.

- These may include some ball valves.

e. Butterfly valve.

2. Valves that control water supplies must be indicating types.

3. Non-indicating valves require manual operation to determine if they are open or closed. These include:

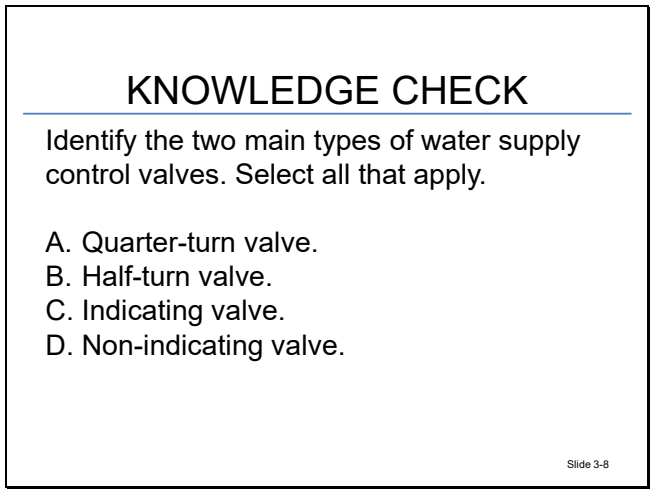
a. Globe valve.

b. Hose bib valve.

c. Valves that perform other functions (but do not control supply) may be non-indicating.

- Water flow test valves.

- Drain valves.



4. If the water supply is a common domestic/sprinkler supply, any control valve must be arranged to shut off both the domestic and sprinkler water supply, or have supervisory alarms.

   Reduces possibility of inadvertent shut-off.

CONTROL VALVES (cont'd)

- Multipurpose sprinkler system may not have control valve unless:
  - Electronically supervised.
  - Locked in open position.



Slide 3-9

5. Sprinkler system piping may not have a separate control valve unless it is supervised by:

   a. Alarm to central, proprietary or remote station service.

   b. Local alarm that sounds at a constantly attended location.

   c. Valves are locked in the open position.

CHECK VALVES

Allows water flow in one direction only.

- Found in water meters and other cross-contamination control devices.
- Not required by standards unless connected to potable system and antifreeze is used.



Slide 3-10

6. A check valve is a directional valve that allows the flow of water in only one direction. The flow direction is indicated with an arrow embossed on the valve housing.

a. Check valves may be used to isolate portions of pipe.

b. Generally, check valves are used in water meter assemblies or as part of cross-contamination control between static water in a sprinkler pipe and potable water for domestic use.

- Cross-contamination control is not a requirement of the NFPA sprinkler standards, but is left to the discretion and regulations of the water purveyor having jurisdiction on the supply.

  -- Cross-contamination control is not required on stored water supplies that serve only the fire sprinkler system.

- Cross-contamination control is required when a sprinkler system designed in accordance with International Residential Code (IRC) P2904 is connected to a potable supply **and** the sprinkler system has a Fire Department Connection (FDC).

  -- If the system contains chemical additives and is connected to a nonpotable secondary water supply, the potable water supply shall be protected against backflow by a reduced pressure principle backflow preventer.

  -- If chemical additives are added to only a **portion** of an automatic fire sprinkler (e.g., attic or unheated garage), the reduced pressure principle backflow preventer may be located where it isolates only that part of the system.

  -- The design and type of cross-contamination control is at the discretion of the water purveyor having jurisdiction on the supply.

DRAIN AND TEST APPARATUS

- All systems shall have a drain valve.
  - Should drain to adequate location to handle water discharge.
    - -- Water discharge flows back into tank for stand-alone systems.



Slide 3-11

C. Drain valves, test valves and assemblies.

1. Sprinkler systems shall have a drain located on the system side of the control valve.

   a. Purpose is to drain the system for maintenance and sprinkler replacement.

   b. Drain shall be at least 1 inch in diameter for NFPA 13R design systems. Size not specified for NFPA 13D or IRC P2904 systems.

   c. One-half-inch drain permitted for trapped portions of dry pipe systems that are subject to freezing in NFPA 13R. Size not specified for NFPA 13D or IRC P2904 systems.

   d. Drain must have a control valve (can be non-indicating).

   e. No specific requirement for where water can be drained. It is recommended that it drain to the outdoors or a large capacity floor drain. If a drain valve is used to test the water flow alarm on a stand-alone system, it must drain back into the storage tank.

2. NFPA 13R systems require a test connection to verify the adequacy of the water supply, as well as to test the required local water flow alarm.

   a. The test connection must have at least a 1-inch diameter and have a control valve (may be non-indicating).

   b. Combination drain and test assemblies are permitted. Where both are installed, a separate test valve is not required.

DRAIN AND TEST APPARATUS (cont'd)

- May be combined with flow test valve, if water flow alarm is provided.



Slide 3-12

3. Where water flow alarms are provided on NFPA 13D and IRC P2904 designs, inspector's test connections should be installed at locations that allow flow testing of water supplies, connections and alarm mechanisms.

   a. The inspector's test connection orifice will be equal to or smaller than the smallest sprinkler installed in the system if sprinklers have a K-factor smaller than 5.6.

   b. Verify sprinkler size from the sprinkler manufacturer's catalog or technical bulletin.

   c. Some water flow test assemblies are included as a combination "test and drain" apparatus.

PRESSURE GAUGES

- NFPA 13D and International Residential Code (IRC) P2904 do not require one on wet pipe.
  - Air pressure gauge required on dry pipe and/or pressure tank systems.



Slide 3-13

D. Pressure gauges (water).

1. NFPA 13D and IRC P2904 do not require water pressure gauges on wet pipe systems.

a. NFPA 13D requires an air pressure gauge on dry pipe systems.

b. Where a pressure tank is used for water supply, a pressure gauge is required to indicate tank pressure.

PRESSURE GAUGES (cont'd)

- NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*: on supply and system sides of main control valve.



Slide 3-14

2. NFPA 13R requires a pressure gauge on the supply side and system side of the main control valves. Pressure gauges are used for visual checks of system status and to evaluate water supply performance during main drain tests.

KNOWLEDGE CHECK

What do NFPA 13D and IRC P2904 require on dry pipe systems but not on wet pipe systems?

A. Control valve.
B. Check valve.
C. Pressure gauge.
D. Water flow alarm.

Slide 3-15

SUPERVISORY/WATER FLOW

- Supervisory not required when combined domestic/fire service.
- NFPA 13D/IRC P2904 do not require water flow if building is provided with smoke detection.



Slide 3-16

E. Supervisory and water flow alarms/switches.

1. NFPA 13R, 13D and IRC P2904 do not require supervisory (tamper) alarms if the domestic and sprinkler systems are supplied by the same source.

2. If a separate sprinkler control valve is provided, it must be supervised by:

   a. Alarm to central, proprietary or remote station service.

   b. Local alarm that sounds at a constantly attended location.

   c. Valves are locked in the open position.

3. NFPA 13D does not require a water flow alarm/switch if dwelling units are provided with smoke alarms or detectors in accordance with NFPA 72, *National Fire Alarm and Signaling Code*®.

4. IRC does not require a water flow alarm/switch. Smoke alarm installation requirements are included in other parts of the code.

SUPERVISORY/WATER FLOW (cont'd)

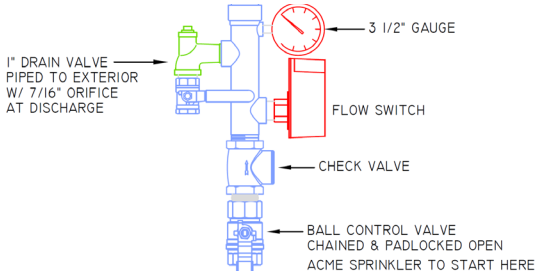
- NFPA 13R requires water flow alarm.
  - If building has fire alarm system, it shall be connected.



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SUPERVISORY/WATER FLOW (cont'd)

Riser diagram: Tyco 513 D/R



Slide 3-18

5. NFPA 13R requires a local water flow alarm/switch.

   a. If the building has a fire alarm system, a local water flow alarm must be connected to it.

   b. Water flow alarm switch installation must be downstream of the main control valve. A water flow alarm, unless part of a listed assembly, should be at least 24 inches downstream of the main control valve.

ALARM

Alarm to notify occupants that water is flowing.

- Required only if no smoke alarms.
- Installed in accordance with NFPA® 72, *National Fire Alarm and Signaling Code*, and manufacturer's specifications.
- Bell, siren or horn.



Slide 3-19



F. FDC.

1. An FDC is not required for NFPA 13D or IRC P2904 design sprinkler systems.

2. For NFPA 13R designs, at least one FDC is required on multifamily buildings that are:

   a. Accessible to the fire department.

   b. More than 2,000 square feet.

   c. More than one story in height.

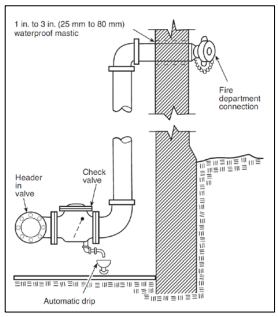
3. For 13R designs, the FDC shall be at least 1 1/2 inches in diameter and equipped with hose threads matching the local fire department standards.

4. For NFPA 13 designs, the FDC shall be at least one inlet (2 1/2 inches in diameter) and equipped with hose threads matching the local fire department standards. Dual inlets are often preferred.

   A single inlet is permitted when riser size is 3 inches in diameter or less.

FIRE DEPARTMENT CONNECTION ARRANGEMENT

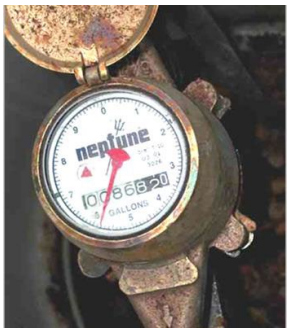
- Check valve direction.
- Located past control valves.
- Pressure test entire system to handle fire department pumping pressure.



Slide 3-21

WATER METERS/BACKFLOW

- Not required as part of sprinkler design standards.
  - Check with local water purveyor.



Slide 3-22

G. Water meters and backflow prevention devices.

1. Not required as part of sprinkler design standards.

a. Left to the discretion and regulations of the water purveyor having jurisdiction on the supply.

WATER METERS/BACKFLOW (cont'd)

- Can have serious negative effect on water flow due to friction loss (as flow increases, so does friction loss).
  - Meter manufacturer for loss values.



Slide 3-23

b. Can have a serious negative effect on water flow due to friction loss through the meter.

- This pressure loss is called "head" loss and varies by meter type, size and manufacturer.

- Always refer to the manufacturer's product literature (catalog "cut sheets" or technical bulletins) to identify the meter's influence on flow.

2. Remember that as flow increases, so does friction.

WATER METER INFLUENCE (SAMPLE)

Pressure Loss (psi) in Various Meter Sizes

Meter size (in.)	18 gpm	23 gpm	26 gpm	31 gpm	39 gpm	52 gpm
5/8	9	14	18	26	*	*
3/4	4	8	9	13	*	*
1	2	3	3	4	6	10
1 1/2	**	1	2	2	4	7
2	**	**	**	1	2	3

* Above maximum flow of commonly available meters.
** Less than one pound per square inch (psi).

From NFPA 13D.

Slide 3-24

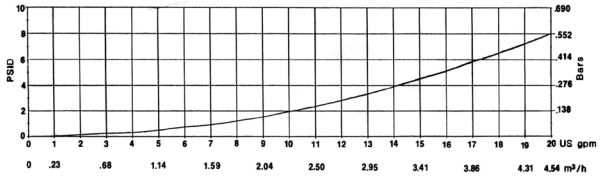
Pressure Loss (psi) in Various Meter Sizes

	Flow in GPM					
Meter size (in.)	**18**	**13**	**26**	**31**	**39**	**52**
5/8	9	14	18	26	*	*
3/4	4	8	9	13	*	*
1	2	3	3	4	6	10
1 1/2	**	1	2	2	4	7
2	**	**	**	1	2	3

*Above maximum flow of commonly available meters.
**Less than 1 pounds per square inch (psi).

WATER METER INFLUENCE (SAMPLE) (cont'd)

Neptune Model T-10 5/8-inch domestic meter loss



Slide 3-25

KNOWLEDGE CHECK

True or false: Water meters are required as part of sprinkler design standards. Explain your answer.

Slide 3-26

III. SPRINKLER SYSTEM DISTRIBUTION AND PIPING

DISTRIBUTION PIPE

- May be one or a combination of:
  - Black iron or steel.
  - Type K, L or M copper.
- Plastic.
  - Post-chlorinated polyvinyl chloride (CPVC).
  - Cross-linked polyethylene (PEX).



Slide 3-27

A. There are a variety of materials that can be used for sprinkler system distribution piping. The design and installation standards describe four major types, but new materials and technologies may be used if they are listed.

1. Whatever piping material is selected, it is expected to be in compliance with the locally adopted plumbing code, especially if the system combines potable and fire protection supplies.

2. The materials described here may be used for underground supply, as well as aboveground distribution piping.

3. Pipe diameter sizes will be established by the sprinkler system's hydraulic demand.

BLACK IRON OR STEEL

- Schedule 40, 30, 10, 7 or 5.
- May be installed exposed.
  - Typical unfinished basement.



Slide 3-28

B. Black iron or steel.

1. Allowed in NFPA 13, 13D and 13R designs; not recognized in the scope of IRC P2904 systems.

   Used for wet, dry or preaction systems.

2. Does not have to be listed if it meets specific ASTM material and dimension standards outlined in the standards.

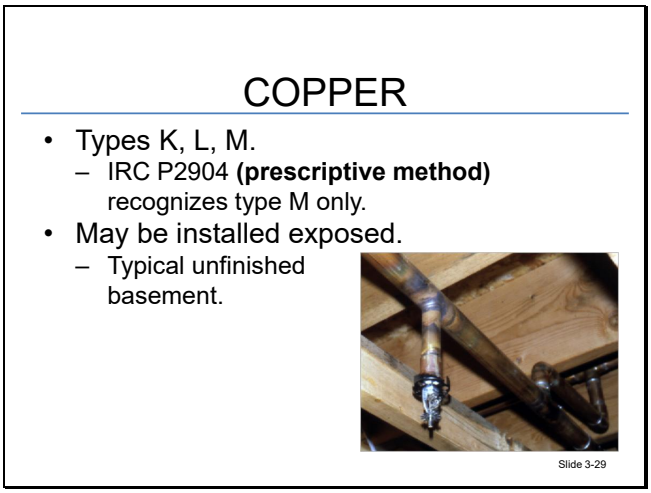
3. Pipe sizes range from 3/4 inch to 2 inches in diameter, depending on system design.

4. May be welded, threaded or grooved for joining pipe sections.

   a. NFPA 13D allows Schedule 10 steel pipe to be joined with mechanical grooved couplings.

   b. NFPA 13R prohibits cut grooves for fittings on pipe less than Schedule 30 thickness and 8 inches or larger in diameter.

   c. NFPA 13R prohibits cut grooves for fittings on pipe less than Schedule 40 thickness and less than 8 inches in diameter.



C. Types K, L and M copper.

1. Allowed in NFPA 13, 13D, 13R and IRC P2904 systems.

   a. Wet pipe, dry pipe or preaction systems.

   b. IRC P2904 recognizes only type M copper when using the prescriptive design option that will be explained in Unit 5: Verifying Sprinkler Coverage and Hydraulic Design.

2. Does not have to be listed if it meets specific ASTM material and dimension standards outlined in the standards.

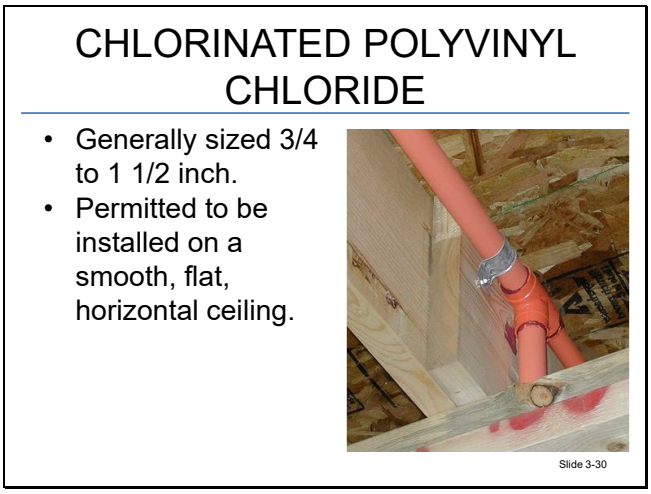
   a. Type K copper has the thickest wall dimensions and is used predominantly in underground burial.

   b. Type L is for general purpose use.

   c. Type M has the thinnest walls and is used for drainage and other low-pressure applications. Some plumbing codes do not permit type M.

3. Pipe sizes range from 3/4 inch to 2 inches in diameter, depending on system design.

4. Joints on wet pipe systems shall be soldered or brazed. Joints on dry pipe and preaction systems shall be brazed.



D. CPVC.

1. Allowed in NFPA 13, 13D, 13R and IRC P2904 systems.

   a. Wet pipe systems only.

   b. Always verify compatibility with other construction products. (See Appendix B: Identified Compatibility Problems with CPVC Pipe in this unit.)

CHLORINATED POLYVINYL CHLORIDE (cont'd)

- Sprinkler protection.
  - Special cases (solid wood joists and quick response sprinklers (QRSs)).
  - Refer to manufacturer's literature.
  - Changing conditions and listings.

Slide 3-31

2. Must be installed in accordance with their listings and manufacturer's installation requirements.

3. Does not have to be listed for fire sprinkler service if it meets specific ASTM material and dimension standards outlined in the standards that **apply to fire protection service.**

CHLORINATED POLYVINYL CHLORIDE (cont'd)

- Shall have a thermal barrier.
  - 3/8-inch wallboard.
  - 1/2-inch plywood gypsum veneer.
  - Suspended membrane ceiling with lay-in panels or tiles having a minimum weight of not less than 0.35 pounds per square foot.

Slide 3-32

4. Compatibility issues.

   Numerous issues have been identified with incompatible materials and their effect on CPVC. Always refer to manufacturer's installation instructions for guidance.

CROSS-LINKED POLYETHYLENE

- Size ranges from 1/2 to 2 inches.
- Intended for network combination systems.
  - Must meet National Sanitation Foundation (NSF) potability standards.

Slide 3-33

CROSS-LINKED POLYETHYLENE (cont'd)

- Suspended membrane ceiling with lay-in panels or tiles having a minimum weight of no less than 0.35 pounds per square foot.



Slide 3-34

E. Cross-linked polyethylene (PEX).

1. Allowed in NFPA 13D and IRC P2904 systems. Wet pipe systems only, and is listed only for multipurpose systems.

   Stand-alone systems require another pipe material: black iron, copper or CPVC.

2. Must be installed in accordance with their listings and manufacturer's installation requirements.

   Multipurpose pipe must be listed for potable water in accordance with the National Sanitation Foundation (NSF).

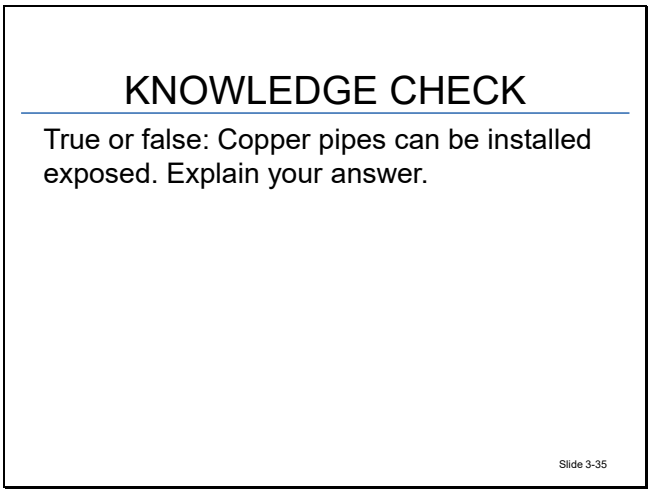
3. Pipe sizes range from 1/2 inch to 2 inches in diameter, depending on system design.

4. Connected to the cold-water distribution in network or looped combination. When connected to the source of both domestic and fire protection water, must meet NSF standards for potability.

F. New products.

1. The marketplace is always developing new products, and it is essential that code officials remain aware of the changes.

2. Pressure-rated polypropylene has been approved by Factory Mutual (FM) Global for light hazard, wet pipe sprinkler systems but is not yet listed by Underwriters Laboratories (UL).



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ACTIVITY 3.1

Identifying Residential Sprinkler System Components

Purpose

Identify specific fire sprinkler components on a drawing.

Directions

Part 1

Working in small groups, refer to the Purple House sprinkler system drawings and identify where the following components are shown. If none exists, strike a line through the component name on the list.

- Main control valve: _____
- Drain valve: _____
- Flow test valve: _____
- Pressure gauge: _____
- Water flow switch: _____
- Check valve: _____

Part 2

Answer the following question: What materials are used for the sprinkler distribution pipe and fittings?

_____

_____

_____

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ACTIVITY 3.2

Identifying Head-Loss Values Caused by Domestic Water Meters

Purpose

Identify head-loss values caused by representative domestic water meters.

Directions

Working in small groups, refer to the sample flow characteristic curves from the samples provided. For each manufacturer, provide the head-loss value at the corresponding flow in gallons per minute (gpm).

Manufacturer	Model	Size	Flow in gpm	Head Loss in psi
Hersey	400 Series IIS	5/8 inch	15	
Jerman	DLJ 100	1 inch	45	
Jerman	DLJ 75	3/4 inch	25	
Neptune	T-10	3/4 inch	23	
Jerman	DLJ 50	1/2 inch	15	
Neptune	T-10	5/8 inch	10	
Hersey	400 Series IIS	1 inch	40	

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QUICK COMPARISON

	NFPA 13	NFPA 13R	NFPA 13D/IRC P2904
Scope	All occupancies	Group R to four stories and 60 feet in height	One- and two-family townhouses
Coverage	Entire building	Occupied spaces	Occupied spaces
Sprinkler design	Control mode, pipe schedule, hydraulic design, minimum 0.1 gallons per minute (gpm)/square foot	Life-safety control mode, four-head design, or 0.05 gpm/square foot	Life-safety control mode, two-head design, or 0.05 gpm/square foot
Sprinklers	All approved types, residential in dwelling unit and adjacent corridor	Residential in dwelling unit and adjacent corridor, other approved types elsewhere	Residential in dwelling unit, other approved types elsewhere
Water demand	System, plus 100 to 500 gpm	± 52 gpm	± 26 gpm
Duration			
Fire Department Connection (FDC)			

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IV. SUMMARY

FEMA U.S. Fire Administration

SUMMARY

- Sprinkler system types include wet pipe, dry pipe and preaction.
  - Antifreeze is a wet pipe system.
- Residential sprinkler system components include water supply control valves, drain valves, test valves and assemblies, pressure gauges, alarms/switches, FDC, and water meters.

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FEMA U.S. Fire Administration

SUMMARY (cont'd)

- Sprinkler system distribution and piping includes black iron or steel; copper, types K, L and M; CPVC; PEX; and new products.

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APPENDIX A

DOMESTIC WATER METER EXEMPLARS

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Hersey Meters

400 Series IIS

Magnetic Drive Positive Displacement Disc Meters
Sizes 5/8" - 3/4" - 1"

Features

APPLICATIONS: Measurement of cold water for residential and small commercial applications where water volumes are low, and low flow sensitivity is important.

CONFORMANCE TO STANDARDS: Hersey Series 400 IIS Water Meters comply with latest version of ANSI/AWWA Standard C700. Meters which are manufactured with the EnviroBrass® maincase option meet the requirements of NSF Standard 61. Each meter is tested to ensure compliance.

CONSTRUCTION: Hersey 400IIS Water Meters consist of three basic parts: maincase; measuring chamber; and permanently sealed register. The maincase is made of bronze for long life. Direction of flow arrows, model and size are cast into each maincase along the top of each casting for easy indentification. The bottom cover is epoxy-coated cast iron with a molded plastic liner separating it from the waterway. Optional plastic and bronze bottom covers are available. The measuring chambers are large for reduced wear during operation. The measuring chamber, integral strainer, nutating disc and thrust roller are thermoplastic, which is dimensionally stable and will not corrode. The thrust roller moves smoothly along a stainless steel wear plate to reduce friction and maintain accuracy. The register box and lid are available in plastic or bronze. The meter is designed so that the register can be replaced without removing the meter from the line.

REGISTER: The permanently sealed register has a unique seal and heat-treated glass to eliminate dirt, moisture infiltration and lens fogging. An integral tamper-proof locking feature is provided to resist tampering with the register. The totalizing register has a straight-reading odometer type display, a 360º test circle with center sweep hand and a low flow (leak) detector. Standard gearing is used, making registers interchangeable by size.

All Hersey meter Models have electronic meter reading systems available for increased reading efficiency (see Meter Reading Systems.)

OPERATION: Water flows through the meter's strainer where debris is screened out. The incoming water fills a known volume of the measuring chamber on one or the other side of a movable disc that separates the chamber into two sections. As water enters, it moves the disc (nutates), forcing a known volume of water out of the meter from the opposite side of the disc. The process repeats as the sections refill and empty in turn. The nutating action of the disc is coupled magnetically to the register to indicate the volume of water that passes through the meter. The large capacity measuring chamber requires fewer nutations of the disc for each gallon measured, which helps to limit wear, extend the life of the meter, and reduce pressure loss.

MAINTENANCE: The Hersey Series 400 IIS Water Meters are designed and manufactured to provide long service life with virtually no maintenance required.

CONNECTIONS: Supplied with external straight pipe threads (NPSM) per ANSI B1.20.1.



Materials and Specifications

- **MODEL NUMBER** 430IIS, 442IIS, 452IIS
- **SIZES** ..... 5/8"x1/2", 5/8"x3/4", 3/4"x3/4", 3/4"x1" and 1"x1"
- **STANDARDS** ..... Manufactured and tested to meet or exceed all applicable parts of ANSI/AWWA C700 Standard EnviroBrass options meet requirements of NSF Standard 61.
- **SERVICE** ..... cold water measurement with flow in only one direction
- **OPERATING FLOW RANGE** ..... See Chart on page 1.2
- **ACCURACY** ..... See Chart on page 1.2
- **PRESSURE LOSS** ..... See Chart on page 1.2
- **MAXIMUM WORKING PRESSURE** ..... 150 PSI
- **TEMPERATURE RANGE** ..... 33ºF to 100ºF Water Temperature
- **MEASURING ELEMENT** ..... Nutating Disc
- **DISC NUTATIONS (per Gallon)** 430IIS: 49.6, 442IIS: 22.4, 452IIS: 11.7
- **REGISTER TYPE** ..... Straight reading, permanently sealed, magnetic drive with low flow indicator. Remote reading units optional.
- **METER CONNECTIONS** ..... 1/2", 3/4", 1" external (NPSM) straight pipe threads per ANSI B1.20.1
- **MATERIALS** ..... Meter case - bronze UNSC84400; Bottom cover - cast iron ASTM A126 CL. B; Chamber top/bottom - thermoplastic; Nutating disc - thermoplastic; Disc pin - stainless steel; Thrust roller - thermoplastic; Wear plate - stainless steel; Coupling - Ceramic magnet; Strainer - thermoplastic; Coupling shaft - stainless steel ANSI B18; Bottom cover bolts - stainless steel ANSI B18; Register box and lid - thermoplastic.
- **OPTIONS** ..... Meter case - EnviroBrass® II UNSC89520 Bottom cover - bronze UNSC84400, EnviroBrass® II UNSC89520 or thermoplastic; Register box and lid - bronze UNSC85700; AMR Reading Systems

400 Series IIS

400 Series IIS

Hersey® Meters

Magnetic Drive Positive Displacement Disc Meters
Sizes 5/8", 3/4" and 1"

Meter Registration

Meter Size	Initial Dial*	Capacity	Initial Dial*	Capacity
5/8"	10 Gallons	10 Million	1 Cubic Feet	1 Million
3/4"	10 Gallons	10 Million	1 Cubic Feet	1 Million
1"	10 Gallons	10 Million	1 Cubic Feet	1 Million

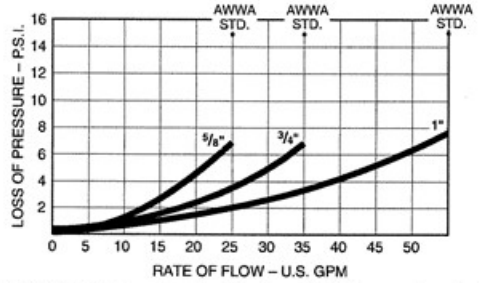
*Registration equal to one full revolution of the sweep hand.

Flow Characteristics

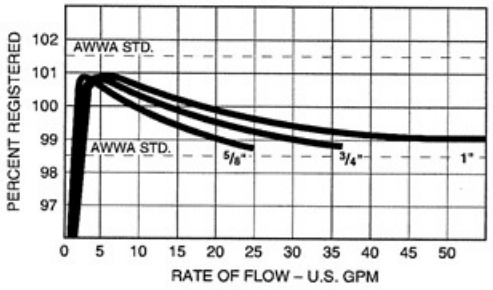
Meter Size	Typical Low Flow (95% Minimum)	Typical Operating Range (100% ± 1.5%)	Maximum Continuous Operation
5/8"	1/4 GPM	1/2 to 25 GPM	15 GPM
3/4"	1/2 GPM	3/4 to 35 GPM	25 GPM
1"	3/4 GPM	2 to 50 GPM	35

Performance

HEAD LOSS - 5/8", 3/4" AND 1" **(Figure 1)**



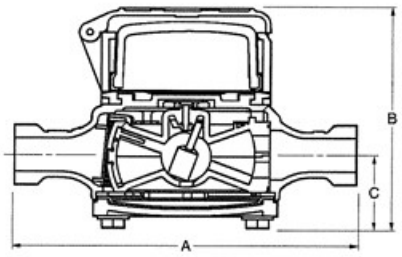
ACCURACY - 5/8", 3/4", AND 1" **(Figure 2)**



NOTE: Performance curves are typical only and NOT a guarantee of performance.

Dimensions and weights

Meter Size	5/8"	3/4"	3/4" Short	3/4" x 1"	1"
	Ends External (NPSM) straight pipe threads				
Model	430	442	442	442	452
Dimensions					
A	7-1/2"	9"	7-1/2"	9"	10-3/4"
B	4-15/16"	5-11/16"	5-11/16"	5-11/16"	6-5/ 8"
C	1-5/8"	1-15/16"	1-15/16"	1-15/16"	2-1/ 8"
Width	4.25"	6.39"	6.39"	6.39"	7.22"
inlet and outlet	1/2" or 3/4"	3/4"	3/4"	1"	1"
Net weight	4-1/2	8-1/2	8	9	11



Note: Weights are in pounds and are approximate.

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PRODUCT SHEET

ARB® UTILITY MANAGEMENT SYSTEMS™

NEPTUNE TECHNOLOGY GROUP

T-10 METER

SIZES: 5/8", 3/4", and 1"



T-10 water meters are warranted for performance, materials, and workmanship.

Every T-10 water meter meets or exceeds the latest AWWA C700 Standard. Its nutating disc, positive displacement principle is time-proven for accuracy and dependability since 1892, ensuring maximum utility revenue.

CONSTRUCTION

The T-10 water meter consists of three major assemblies: a register, a no-lead high copper alloy maincase, and a nutating disc measuring chamber.

The T-10 meter is available with a variety of register types. For reading convenience, the register can be mounted in one of four positions on the meter.

The corrosion-resistant no-lead high copper alloy maincase will withstand most service conditions: internal water pressure, rough handling, and in-line piping stress.

The innovative floating chamber design of the nutating disc measuring element protects the chamber from frost damage while the unique chamber seal extends the low flow accuracy by sealing the chamber outlet port to the maincase outlet port. The nutating disc measuring element utilizes corrosion-resistant materials throughout and a thrust roller to minimize wear.

WARRANTY

Neptune provides a limited warranty with respect to its T-10 water meters for performance, materials and workmanship.

When desired, maintenance is easily accomplished either by replacement of major assemblies or individual components.

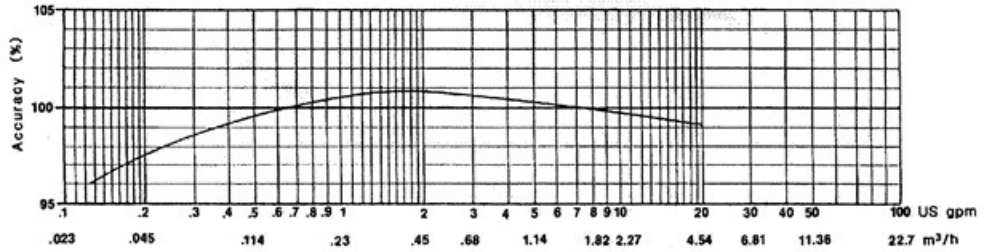
KEY FEATURES

- Register
  - Magnetic drive, low torque registration ensures accuracy
  - Impact-resistant register
  - High resolution, low flow leak detection
  - Bayonet style register mount allows in-line serviceability
  - Tamperproof seal pin deters theft
  - Date of manufacture, size, and model stamped on dial face
- No-Lead Maincase
  - Made from no-lead high copper alloy
  - ANSI/NSF 61 Certified
  - Lifetime guarantee
  - Resists internal pressure stresses and external damage
  - Handles in-line piping variations and stresses
  - No-lead high copper alloy provides residual value vs. plastic
  - Electrical grounding continuity
- Nutating Disc Measuring Chamber
  - Positive displacement
  - Widest effective flow range for maximum revenue
  - Proprietary polymer materials maximize long term accuracy
  - Floating chamber design is unaffected by meter position or in-line piping stresses

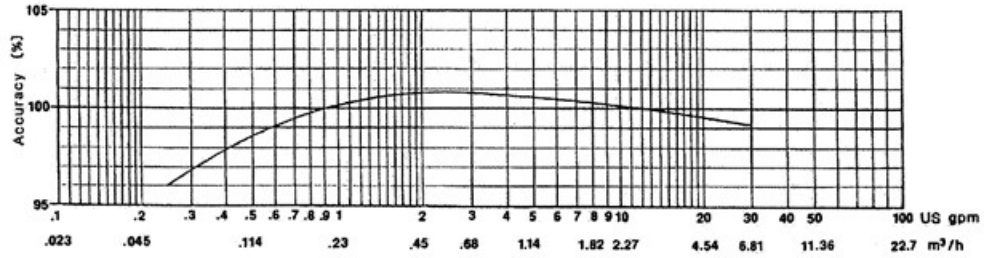
SYSTEMS COMPATIBILITY

Adaptability to all present and future systems for flexibility is available only with Neptune's ARB® Utility Management Systems™.

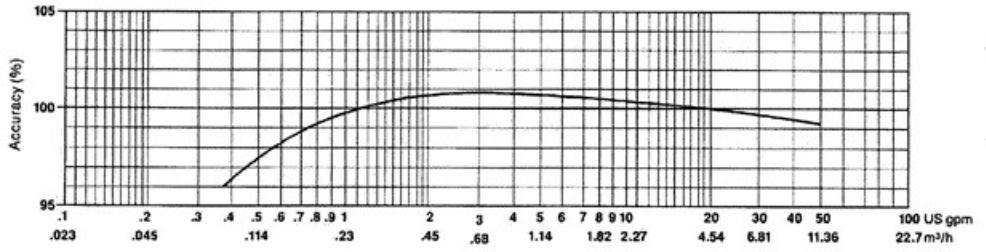
5/8" ACCURACY



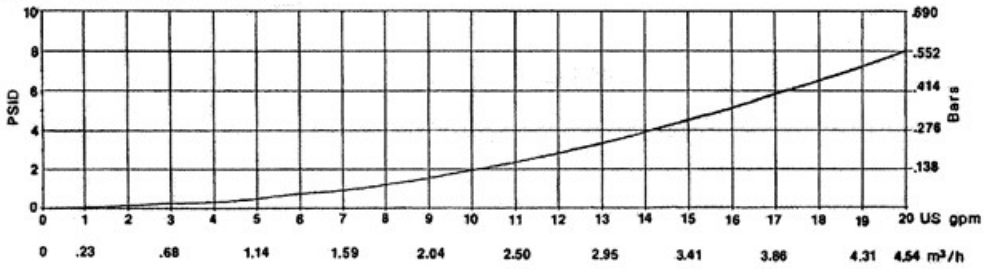
3/4" ACCURACY



1" ACCURACY

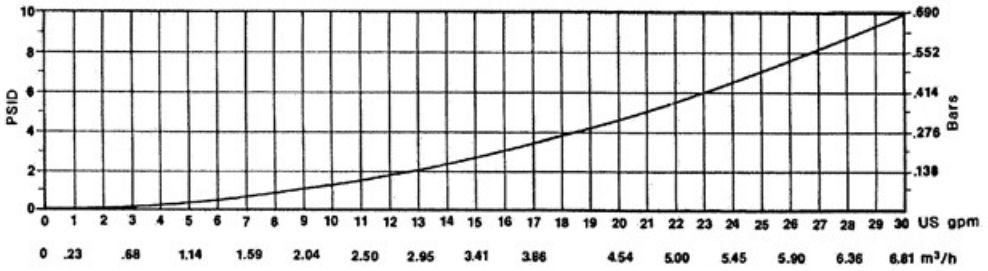


5/8" PRESSURE LOSS

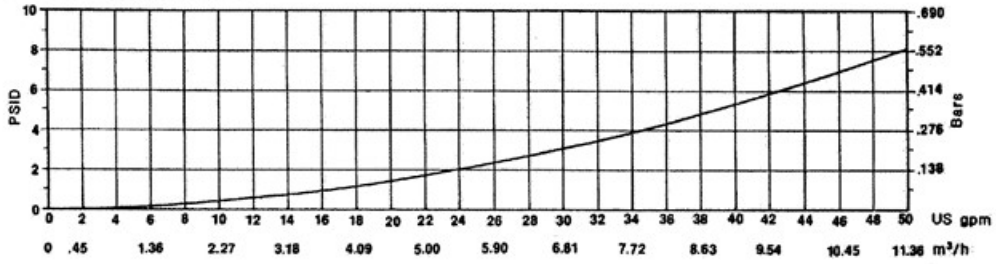


These charts show typical meter performance. Individual results may vary.

3/4" PRESSURE LOSS



1" PRESSURE LOSS

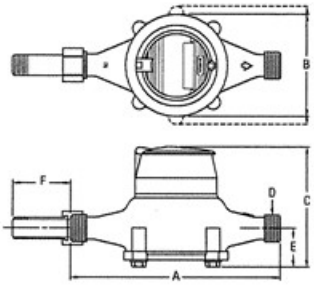


OPERATING CHARACTERISTICS

Meter Size	Normal Operating Range @100% Accuracy (±1.5%)	AWWA Standard	Low Flow @ 95% Accuracy
5/8"	1/2 to 20 US gpm 0.11 to 4.55 m3/h	1 to 20 US gpm 0.23 to 4.5 m3/h	1/8 US gpm 0.03 m3/h
3/4"	3/4 to 30 US gpm 0.17 to 6.82 m3/h	2 to 30 US gpm 0.45 to 6.8 m3/h	1/4 US gpm 0.06 m3/h
1"	1 to 50 US gpm 0.23 to 11.36 m3/h	3 to 50 US gpm 0.68 to 11.4 m3/h	3/8 US gpm 0.09 m3/h

DIMENSIONS

Meter Size	A in/mm	B in/mm	C-Std. in/mm	C-ARB in/mm	D-Threads per inch	D-OD in/mm	E in/mm	F in/mm	Weight lbs/kg
5/8"	7 1/2 191	3 5/8 92	4 7/8 124	5 3/8 137	14	1.030 26	1 5/8 41	2 1/2 64	3 3/4 1.7
5/8" x 3/4"	7 1/2 191	3 5/8 92	4 7/8 124	5 3/8 137	11 1/2	1.290 33	1 5/8 41	2 5/8 67	4 1.8
3/4"	9 229	4 3/8 111	5 1/2 140	5 13/16 148	11 1/2	1.290 33	1 7/8 48	2 5/8 67	6 2.7
3/4"SL	7 1/2 911	4 3/8 111	5 1/2 140	5 13/16 148	11 1/2	1.290 33	1 7/8 48	2 5/8 67	5 1/2 2.5
3/4"x1"	9 229	4 3/8 111	5 1/2 140	5 13/16 148	11 1/2	1.626 41	1 7/8 48	2 3/4 70	6 1/2 2.9
1"	10 3/4 273	6 1/2 165	6 3/8 162	6 5/8 168	11 1/2	1.626 41	2 1/8 54	2 3/4 70	9 3/4 4.4
1"x1 1/4"	10 3/4 273	6 1/2 165	6 3/8 162	6 5/8 168	11 1/2	1.865 47	2 1/8 54	2 13/16 71	10 1/4 4.6



GUARANTEED SYSTEMS COMPATIBILITY

All T-10 water meters are guaranteed adaptable to our ARB®V, ProRead (ARB VI) AutoDetect, E-Coder™(ARB VII), E-Coder)R900*i*, TRICON®/S, TRICON/E3®, and Neptune meter reading systems without removing the meter from service.

REGISTRATION

ProRead Registration (per sweep hand revolution)		5/8"	3/4" & 1"
10	US Gallons	✓	✓
10	Imperial Gallons	✓	✓
1	Cubic Foot	✓	✓
0.1	Cubic Metre	✓	✓
0.01	Cubic Metre	✓	
Register Capacity ProRead & E-Coder		**5/8"**	**3/4" & 1"**
10,000,000	US Gallons	✓	✓
10,000,000	Imperial Gallons	✓	✓
1,000,000	Cubic Feet	✓	✓
100,000	Cubic Metres	✓	✓
10,000	Cubic Metres	✓	
E-Coder High Resolution (8-digit reading)		**5/8"**	**3/4" & 1"**
0.1	US Gallons	✓	✓
0.1	Imperial Gallons	✓	✓
0.01	Cubic Feet	✓	✓
0.001	Cubic Metres	✓	✓

SPECIFICATIONS

- Certification: ANSI/NSF 61
- Application: Cold water measurement of flow in one direction
- Maximum operating water pressure: 150 psi (1034 kPa)
- Maximum operating water temperature: 80°F
- Measuring chamber: Nutating disc technology design made from proprietary synthetic polymer

OPTIONS

- Sizes:
  - 5/8", 5/8" x 3/4"
  - 3/4", 3/4" SL, 3/4" x 1"
  - 1", 1" x 1 1/4"
- Units of measure: U.S. gallons, imperial gallons, cubic feet, cubic metres
- Register types:
  - Direct reading: Bronze box and cover (standard)
  - Remote reading: ProRead Encoder, E-Coder™, E-Coder)R900*i*, TRICON/S, TRICON/E3
  - Reclaim
- Bottom caps:
  - Synthetic polymer (5/8" only)
  - Cast iron
  - No-lead high copper alloy
- Connections:
  - No-lead high copper alloy, straight or bent
- Environmental conditions:
  - Operating temperature: 33°F to 149°F (0°C to 65°C)
  - Storage temperature: 33°F to 158°F (0°C to 70°C)

Neptune engages in ongoing research and development to improve and enhance its products. Therefore, Neptune reserves the right to change product or system specifications without notice.

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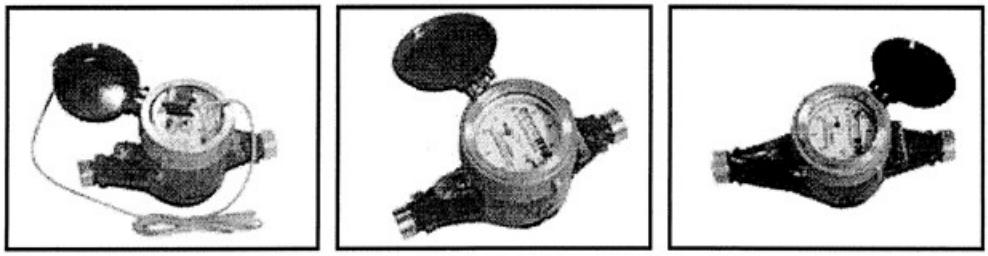
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DLJ Epoxy Coated Bronze Water Meters

Models DLJ 50, DLJ 75, DLJ 7575, DLJ 100



Description

Operation The DLJ 50, 75, 7575 and 100 are multijet (inferential) impeller meters. The impeller and magnet are the only moving parts in the measuring chamber. The chamber is located in a strainer basket, which allows for high amounts of impurities to be passed through the meter without affecting operation. The impeller movement is transferred by a magnetic coupling to the hermetically sealed register.

Compliance The DLJ line of multijets complies with AWWA C708 and ISO 4064 Class B standards.

Installation The meter must be installed in a clean pipeline, free of any foreign materials. Install the meter with direction of flow as indicated by the arrow cast into the meter body. You can install the meter vertically or horizontally and with the register facing any direction.

Application The DLJ meter is for use only with cold water up to 122 degrees F (50 degrees C)

Construction The meter consists of an epoxy coated bronze maincase with the size and flow direction cast into it, an integral strainer/measuring chamber, a removable dry hermetically sealed register assembly and a secured calibration port (factory tested and set).

	Specifications			
Characteristics	**DLJ 50 5/8" x 1/2"**	**DLJ 75 5/8" x 3/4"**	**DLJ 7575 3/4" x 3/4"**	**DLJ100 1"**
Flow Rating (gpm)	20	20	30	50
Continuous Flow (gpm)	15	20	25	30
Normal Flow Range (gpm)	1 - 20	1 - 20	2-30	3 - 50
Low Flow (gpm)	1/4	1/4	1/4	1/2
Maximum Pressure (psi)	150	150	150	150
Maximum Temperature (°F)	122	122	122	122
Sweep Hand Registers (Gallons)	10	10	10	10
Register Capacity (Millions of Gallons)	10	10	10	10

watermeters.com
the first and still the best online source for water meters

DLJ Meter



www.watermeters.com

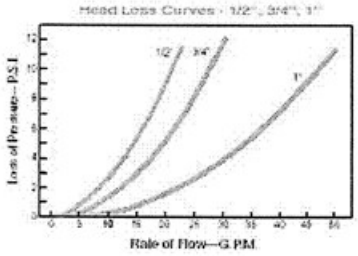
DLJ Bronze Water Meter from watermeters.com

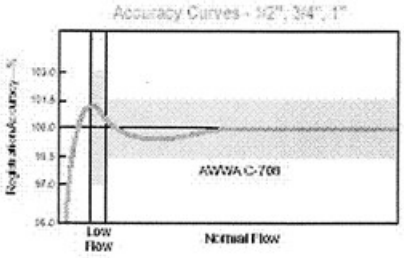
DLJ Epoxy Coated Bronze Water Meters

Models DLJ 50, DLJ 75, DLJ 7575, DLJ 100

Direct Read Register The register is contained in a hermetically sealed nylon casing with a 5mm tempered glass lens. The totalizer wheels are large and easy to read and the sweep hand is designed not to interfere with the odomoter reading. The register's circumference shows individual gallons down to increments of tenths of gallons, for precision reading. The large red spinng trickle indicator is excellent for leak detection. Each register clearly show's it's applicable meter size.







Pulse Output The DLJ line is available with a dry contact reed switch pulse output. This requires external DC power, 4 watts, 30VDC maximum. Contact closure is 1 pulse per gallon.



Magnetic Drive The magnetic drive design facilitates coupling between the measuring chamber and the register assembly. The coupling will remain unless the flow rates are higher than recommended

Maintenance The register assembly is easily removable and replaceable if needed. The integral strainer on the measuring assembly prevents foreign debris damage and can be removed and flushed clean if merited.

Connections Meter casing spuds conform to ANSI B2.1 and have external straight threads (referred to as non-tapered meter threading). All meters come with full bronze meter coupling sets bringing you to Male NPT.

Specifications	Size			
	DLJ 50 5/8" x 1/2"	DLJ 75 5/8" x 3/4"	DLJ 7575 3/4" x 3/4"	DLJ100 1"
Length	7 1/2"	7 1/2"	9"	10 3/4"
Height	4 1/8"	4 1/8"	4 1/8"	3 7/8"
Width	3 3/4"	3 3/4"	3 3/4"	4 1 /8"
Weight (lbs.)	4	4	5	5

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DLJ Meter



www.watermeters.com

APPENDIX B

IDENTIFIED COMPATIBILITY PROBLEMS WITH CPVC PIPE

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Identified Compatibility Problems with CPVC Pipe

Source: Harvel Blazemaster

Thread Sealants: Some thread paste sealants contain solvents, oils or other chemical additives that can cause damage to CPVC. Only compatible thread sealants and tapes should be used with CPVC.

Fire Stop Materials: Some fire stop sealants contain solvents, plasticizers or other chemical additives that can cause damage to CPVC. Only compatible fire stop materials should be used with CPVC.

Antifreeze Solutions: DO NOT USE GLYCOL BASE ANTIFREEZE SOLUTIONS. The use of improper antifreeze solutions such as ethylene glycol, propylene glycol and/or contaminated glycerin solutions can cause stress cracking of CPVC resulting piping system failure. Antifreeze solutions of U.S.P. or C.P. grade GLYCERIN are acceptable for use with CPVC fire sprinkler products.

Soldering/Hot Work: Soldering of metallic components in close proximity to CPVC piping will cause damage to CPVC piping systems. Direct contact with heat (open flame), solder, and soldering flux is not recommended. These types of products should be isolated from direct contact with CPVC piping products. CPVC contact with solder flux can cause cracks, leaks and breaks in the piping system. Any CPVC pipe or fittings that have solder flux on them (as identified by staining or discoloration of the pipe and fittings) should be removed and replaced with new CPVC materials.

Flexible Wire: Direct contact with flexible wire and cable should be avoided as the insulation for the wire and cable can contain plasticizers that can cause CPVC piping systems to crack, leak or break. The finished installation should be inspected to verify that the fire sprinkler system is not being used to support wire or cable, and that runs of wire and cable have not been pulled over the installed CPVC system. Additionally, the CPVC piping systems should not be supported with electrical cable or flexible wiring, and all hanger support recommendations should be followed.

Steel Pipe Transitions: Transitions from steel pipe to CPVC pipe can be made through a variety of methods such as threaded, flanged, and grooved transition components. Occasionally, the steel pipe may contain residual oils that were used to aid in the metal cutting process. Some of the oils used for this purpose may be incompatible with CPVC. These cutting oils should be removed from the steel pipe prior to connecting to CPVC pipe by fully cleaning the inside and outside of the pipe before it is assembled in the fire sprinkler system. Care should be taken when selecting cleaning agents to avoid further contamination of the pipe with such elements as surfactants. If cutting oil is used consult with the manufacturer of the cutting oil for a specific recommendation as to compatibility with CPVC.

Antimicrobial Coatings on Metallic Piping: Recently concerns have been raised regarding the use of certain antimicrobial coatings found on some steel pipe. Recent information indicates that certain antimicrobial coatings contain environmental stress cracking agents that can be detrimental to CPVC.

In addition, the use of aftermarket antimicrobial coatings shall not be used to apply to untreated steel pipe that is used in conjunction with CPVC, unless that coating has also proven to be compatible with CPVC.

Paint: Oil or solvent-based paints may be chemically incompatible with CPVC. Water-based acrylic or latex paint is the preferred paint to use on CPVC pipe and fittings. Approval from the Authority Having Jurisdiction shall be obtained prior to covering/painting the markings on the product (i.e. product identification, listing marks, etc.) and to change color of the pipe and fittings from its identifiable orange.

Polyurethane (Spray-On) Foams: The chemical compatibility of polyurethane foams with CPVC is currently under investigation by CPVC material suppliers. This process may take some time to complete. Therefore, at this time, we cannot say whether such products are compatible with CPVC. In addition to a potential chemical compatibility concern, it is known that when polyurethane foams are not properly applied there is the potential for excess heat that can lead to ballooning of the pipe and a subsequent failure. Exothermic reactions can occur during application of the foam that can generate excessive heat causing softening and failure of the CPVC pipe. It is recommended that the CPVC pipe be isolated from direct contact with spray foam insulation until more definitive information becomes available.

Cooking Oils and Grease: When CPVC pipe is installed in kitchen areas the pipe shall be protected from contact with grease or cooking oils. Certain cooking oils can cause the CPVC piping to crack, leak or break when applied to the piping system. Consideration shall be given to not only protecting the pipe from direct contact with cooking oils and/or grease, but also contact that may occur from airborne grease or oil from the environment such as cooking. Exposed piping in areas where CPVC pipe might come in contact with cooking oils and grease should be protected using a soffit system or with a complete coating of high quality water based paint that fully protects the piping system.

Rubber and Flexible Materials: CPVC is typically not compatible with rubber and flexible plastic materials as these materials often contain certain types of plasticizers which when placed in contact with CPVC can cause the piping system to crack, leak or break. (Incompatible plasticizers include, but are not limited to, phthalates, adipates, trimellitates, dibenzoates, etc.) Incompatible rubber and flexible plastic materials can be found in hoses and tank linings and in the fluids that come in contact with them.

Spray-On Coatings: Certain types of spray-on coatings that form a peelable film to protect fixtures during construction may be incompatible with CPVC. Care should be used to protect exposed piping from over-spray when this type of protective coating is applied.

Termiticides and Insecticides: When performing installations underslab or where the presence of insecticides or termiticides is likely, care should be taken to isolate CPVC pipe from direct contact with large quantities (what is the quantity) of these chemicals. CPVC can be damaged when termiticides or insecticides are injected into the annular space between the pipe wall and sleeving material trapping the termiticide against the pipe wall. Termiticide applications per label instructions in an open-air environment, such as slab pretreat applications, should not pose a problem. However, puddling of termiticides on or near CPVC pipe may cause failures. In areas

where puddling is more likely, such as areas near tub boxes and retreat applications, extra care should be taken to avoid puddling of termiticides. Before using an insecticide or termiticide, be sure to consult the manufacturer's installation guide for proper application instructions.

Mold Abatement and Fungicides: Building restoration projects used to repair water damage often include the use of mold abating products such as fungicides. These products can damage CPVC piping systems and can cause cracks, leaks, or breaks in the system. When performing repairs or modifications care should be taken to isolate the CPVC piping system from direct contact with fungicide products. When repairs are made to an existing system, and the possibility exists that fungicides will be applied to treat damp drywall and wood framing surrounding the repair site, exposed piping should be sleeved with a compatible plastic sleeves or pipe insulation material to prevent direct contact of the fungicide with the CPVC piping system.

For more information, refer to the Lubrizol site at:

https://www.lubrizol.com/CPVC/FBC-System-Compatible-Program/System-Compatible-Product-Finder

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APPENDIX C

CORROSION ISSUES WITH METALLIC PIPE AND TUBE

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Corrosion Issues with Metallic Pipe and Tube

Corrosion is the chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties.

Microbiologically influenced corrosion (MIC) is corrosion brought about by the presence and/or activities of microorganisms in biofilms on the surface of the corroding material. These microorganisms can influence corrosion by effects such as differential aeration cells or the production of corrosive species, such as mineral and organic acids, ammonia, and the reduction of sulfate to sulfide.

Electrochemically influenced corrosion is corrosion that occurs on contact with water (and moisture in the air), acids, bases, salts, oils, aggressive metal polishes, and other solid and liquid chemicals. Metals will also corrode when exposed to gaseous materials like acid vapors, formaldehyde gas, ammonia gas and sulfur-containing gases.

Galvanic corrosion is accelerated corrosion of a metal because of an electrical contact with a more noble metal (or nonmetallic conductor in a corrosive electrolyte). A “noble metal” is a metal with a standard electrode potential that is more noble (positive) than that of hydrogen, including ruthenium, rhodium, palladium, silver, osmium, iridium, platinum and gold.

The resistance of all grades of copper to atmospheric corrosion is good. The metal develops adherent protective coatings, initially of oxide, but subsequently thickening to give a familiar green patina on roofs and the dark brownish color of bronze statuary.

Copper is largely unaffected by potable water, so it is widely used for tubes carrying domestic and industrial water.

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UNIT 4:
SPRINKLERS AND SPRINKLER LAYOUT

TERMINAL OBJECTIVE

The students will be able to:

4.1 Evaluate the residential sprinkler system's overhead pipe, sprinklers and design for compliance with national standards and codes.

ENABLING OBJECTIVES

The students will be able to:

4.1 Evaluate pipe configurations used for water distribution.

4.2 List where the national standards permit omissions from sprinkler coverage.

4.3 Describe the following distribution arrangements: tree, grid, loop and network.

4.4 Differentiate the type and location of sprinkler pipe hangers and restraints, as well as sprinkler types and Sprinkler Identification Numbers (SINs).

4.5 Explain the requirements for thermal protection for nonmetallic pipe and the different performance characteristics between property protection and residential sprinklers.

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FEMA

U.S. Fire Administration

UNIT 4: SPRINKLERS AND SPRINKLER LAYOUT

Slide 4-1

TERMINAL OBJECTIVE

Evaluate the residential sprinkler system's overhead pipe, sprinklers and design for compliance with national standards and codes.

Slide 4-2

ENABLING OBJECTIVES

- Evaluate pipe configurations used for water distribution.
- List where the national standards permit omissions from sprinkler coverage.
- Describe the following distribution arrangements: tree, grid, loop and network.

Slide 4-3

ENABLING OBJECTIVES (cont'd)

- Differentiate the type and location of sprinkler pipe hangers and restraints, as well as sprinkler types and Sprinkler Identification Numbers (SINs).
- Explain the requirements for thermal protection for nonmetallic pipe and the different performance characteristics between property protection and residential sprinklers.

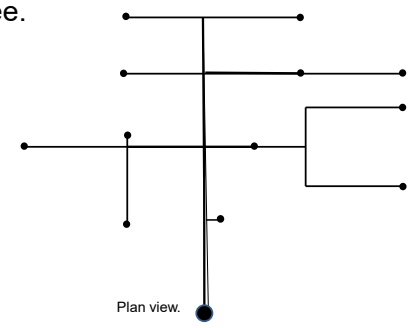
Slide 4-4

I. SPRINKLER SYSTEM LAYOUT

A. The types of configurations include tree, grid, looped and networked.

SYSTEM LAYOUTS

- Tree.

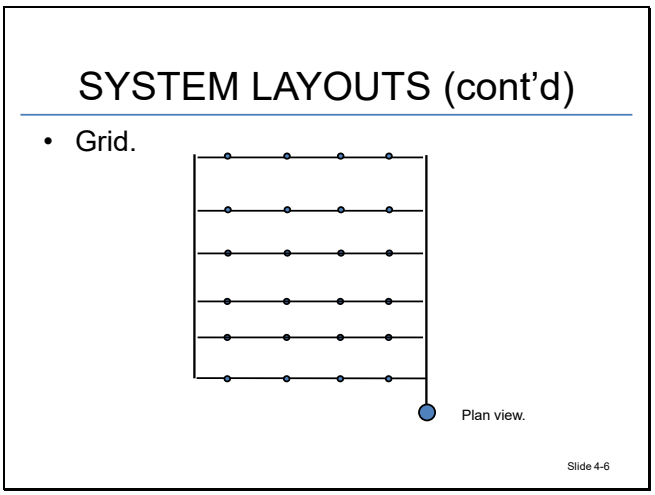


Plan view.

Slide 4-5

1. Tree.

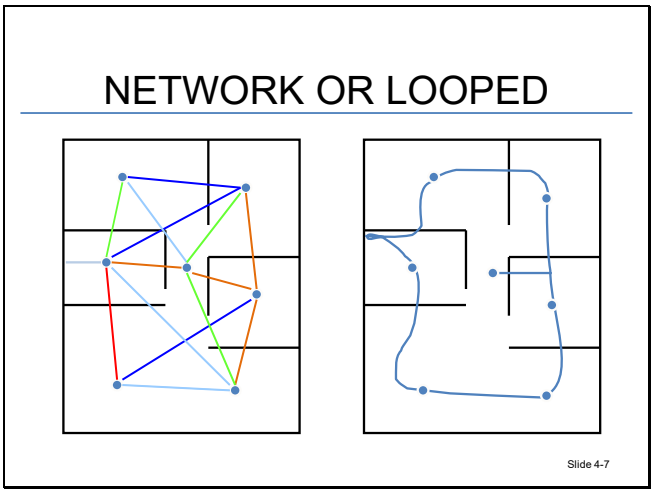
   Single-feed main that distributes water to the system through progressively smaller cross mains and branch lines, usually terminating with sprinklers on a dead-end pipe.



2. Grid.

   a. Parallel cross mains are connected by multiple branch lines.

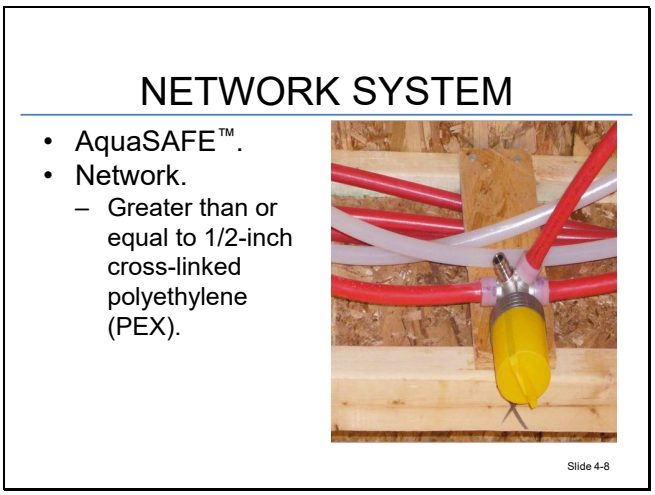
   b. Branch lines are generally all the same size.



3. Loop.

   a. Multiple cross mains are tied together to provide more than one path of water flow to operating sprinklers.

   b. Branch lines are not tied together but usually terminate with sprinklers on a dead-end pipe.



4. Network (National Fire Protection Association (NFPA) 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*).

   a. A combination system, which supports both the domestic water supply and the sprinkler system, where each sprinkler is supplied by a minimum of three separate paths:

      - One goes back to home run.

      - One 1/2-inch connection between sprinklers.

   b. The premier characteristic of a combination system is that water constantly flows throughout the system, generally eliminating the need for cross-contamination control.

      - International Residential Code (IRC) P2904 specifically states no cross-contamination control is needed on a combined domestic fire system if no antifreeze is used.

   c. Network designs tend to be **proprietary.**

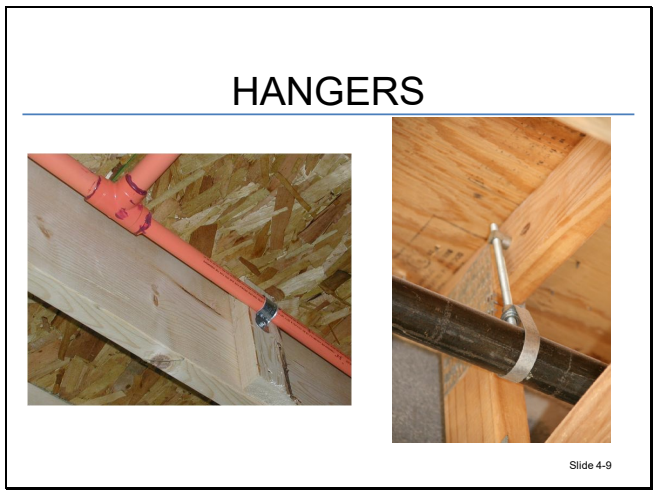
      - The materials and design are under the control of the product manufacturer.

      - The system shall be installed precisely as the manufacturer requires, often by specially trained personnel.

      - Currently, popular network designers include:

         -- Kwench systems.

-- Uponor AquaSAFE™ systems.

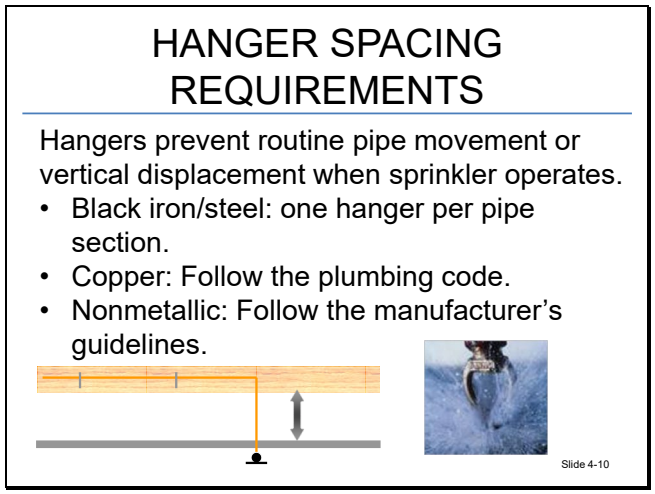


B. Pipe hangers and restraints.

1. Hangers are an integral part of the system to prevent routine pipe movement or vertical displacement when a sprinkler operates.

   a. Strict requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, do not apply since most residential pipe sizes range from 3/4 inch to 2 inches.

   b. Dynamic and static loads caused by water flow are less in smaller pipe than larger systems designed in accordance with NFPA 13.



   c. Not only do hangers support the weight of the water-filled pipe, they hold the pipe in place when it reacts to water flow from the sprinklers.

2. Listed pipe shall be supported in accordance with listing requirements and manufacturer's installation requirements.

3. Unlisted pipe, or listed pipe that does not include piping support requirements, shall be supported from the structure in accordance with local plumbing codes.

KNOWLEDGE CHECK

What distribution arrangement uses parallel cross mains that are connected by multiple branch lines?

A. Tree.
B. Grid.
C. Loop.

Slide 4-11

THERMAL BARRIERS

- A thermal barrier is required due to engineered wood joists.



Slide 4-12

C. Thermal protection for nonmetallic pipe (chlorinated polyvinyl chloride (CPVC)), polybutylene (PB) and cross-linked polyethylene (PEX).

1. Nonmetallic pipes shall generally have a thermal barrier between the occupied space and the pipe. This is intended to protect the pipe from flame impingement or heat long enough for the sprinklers to operate and cool the thermal plume.

   Exceptions exist for some rigid nonmetallic pipe under specific types of construction when the space is protected by automatic sprinklers.

2. PEX always requires thermal barriers on the walls and ceilings where it may be exposed to flame impingement or heat.

THERMAL BARRIERS (cont'd)

- Sprinkler protection.
  - Special cases.
  - Refer to manufacturer's literature.



Slide 4-13

3. Always refer to the pipe manufacturer's installation instructions for guidance. These can be downloaded from the manufacturer's website.

   Where required, thermal barriers shall consist of one of the following options:

   a. Gypsum wallboard — 3/8 inch.

   b. Plywood veneer — 1/2 inch.

   c. Suspended membrane ceiling (T-bar grid) with lay-in panels, or tiles having a minimum weight of no less than 0.35 pounds per square foot, shall be hung on metallic supports.

UNFINISHED BASEMENTS

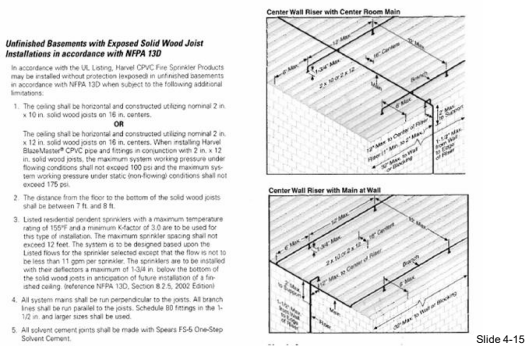
- May be exposed if it uses solid wood joist construction.
- Follow manufacturer's requirements.



Source: Harvel BlazeMaster.

Slide 4-14

UNFINISHED BASEMENTS (cont'd)



Unfinished Basements with Exposed Solid Wood Joist Installations in accordance with NFPA 13D

In accordance with the UL Listing, Harvel CPVC Fire Sprinkler Products may be installed without protection (exposed) in unfinished basements in accordance with NFPA 13D when subject to the following additional limitations:

1. The ceiling shall be horizontal and constructed utilizing nominal 2 in. x 10 in. solid wood joists on 16 in. centers.
   OR
   The ceiling shall be horizontal and constructed utilizing nominal 2 in. x 12 in. solid wood joists on 16 in. centers. When installing Harvel BlazeMaster® CPVC pipe and fittings in conjunction with 2 in. x 12 in. solid wood joists, the maximum system working pressure under flowing conditions shall not exceed 100 psi and the maximum system working pressure under static (non-flowing) conditions shall not exceed 175 psi.
2. The distance from the floor to the bottom of the solid wood joists shall be between 7 ft. and 8 ft.
3. Listed residential pendent sprinklers with a maximum temperature rating of 155°F and a minimum K-factor of 3.0 are to be used for this type of installation. The maximum sprinkler spacing shall not exceed 12 feet. The system is to be designed based upon the Listed flows for the sprinkler selected except that the flow is not to be less than 11 gpm per sprinkler. The sprinklers are to be installed with their deflectors a maximum of 1-3/4 in. below the bottom of the solid wood joists in anticipation of future installation of a finished ceiling. (reference NFPA 13D, Section 8.2.5, 2002 Edition)
4. All system mains shall be run perpendicular to the joists. All branch lines shall be run parallel to the joists. Schedule 80 fittings in the 1-1/2 in. and larger sizes shall be used.
5. All solvent cement joints shall be made with Spears FS-5 One-Step Solvent Cement.

Slide 4-15

D. Special characteristics for dry pipe or dual interlock preaction systems.

Pipe shall be pitched to low point for drainage.

1. Branch lines at least 1/2 inch per 10 feet.

2. Cross or feed mains at least 1/4 inch per 10 feet.

3. For dry pipe systems using CPVC pipe, a thermal barrier is required, and the ambient temperature cannot be less than -20 F (-28.9 C).

KNOWLEDGE CHECK

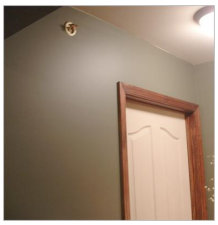
True or false: A sprinkler system may be exposed in an unfinished basement if it uses solid wood joints for construction. Explain your answer.

Slide 4-16

II. RESIDENTIAL SPRINKLERS

SPRINKLER LOCATIONS

To provide minimum level of life safety, sprinklers shall be installed in all **normally occupied** portions of a dwelling unit.





Slide 4-17

A. To provide a minimum level of life safety, sprinklers shall be installed throughout all **normally occupied** (where fires occur and have impacted life, with exceptions) portions of a dwelling unit.

SPRINKLER LOCATIONS (cont'd)



Slide 4-18

NFPA 13R AND 13D/IRC P2904

- The National Fire Protection Association (NFPA) and the International Residential Code (IRC) say sprinklers may be omitted from those areas where there is little statistical likelihood a fatal fire will start:
  - Attics, garages, open attached porches and carports.

Slide 4-19

B. National standards permit omissions from sprinkler coverage in:

1. Attics, garages, open attached porches and carports.

   International Fire Code (IFC) and IRC require sprinklers beneath combustible decks in multifamily dwellings.

NFPA 13R AND 13D/IRC P2904 (cont'd)

- Bathrooms 55 square feet and less.
- Interior clothes closets, linen closets and pantries.
  - -- Less than 24 square feet.
  - -- Walls and ceilings are surfaced with noncombustible or limited-combustible materials.
  - -- With smallest dimension not greater than 3 feet (NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, only).

Slide 4-20

2. Bathrooms 55 square feet and less.

3. Clothes closets, linen closets and pantries:

   a. Less than 24 square feet.

   b. Less than 3 feet in the smallest dimension.

NFPA 13R AND 13D/IRC P2904 (cont'd)

  - -- Exception to previous: closets containing heating or air-conditioning equipment, washers, dryers or water heaters.
- Penthouse equipment rooms, elevator machine rooms.
- Concealed spaces dedicated exclusively to and containing only dwelling unit ventilation equipment.

Slide 4-21

4. Penthouse equipment rooms, elevator machine rooms.

5. Concealed spaces dedicated exclusively to and containing only dwelling unit ventilation equipment.

NFPA 13R AND 13D/IRC P2904 (cont'd)

- No sprinklers required in:
  - Floor/Ceiling spaces.
  - Elevator shafts.
  - Crawlspaces.
  - Other concealed spaces that are not used nor intended for living purposes **and** do not contain fuel-fired equipment.
  - Exception: One sprinkler required in area of fuel-fired equipment.

Slide 4-22

NFPA 13R AND 13D/IRC P2904 (cont'd)

- Exception: When fuel-fired equipment is present, at least one quick-response intermediate temperature sprinkler shall be installed above it.



Slide 4-23

6. Floor/Ceiling spaces, elevator shafts, crawlspaces and other concealed spaces that are not used nor intended for living purposes and do not contain fuel-fired equipment.

   Exception: In attics, crawlspaces and normally unoccupied spaces that have fuel-fired equipment, one quick response intermediate temperature (175 to 225 F (79 to 107 C)) sprinkler is required over equipment but not throughout the rest of the space.

NFPA 13R AND 13D/IRC P2904 (cont'd)

– Covered, unheated canopies at entrances/ exits as long as there is another means of egress from the dwelling unit.

Slide 4-24

7. Covered, unheated canopies at entrances/exits as long as there is another means of egress from the dwelling unit.

KNOWLEDGE CHECK

Where are sprinklers **not** required? (Select all that apply.)

A. Basements.
B. Concealed spaces not for living purposes.
C. Crawlspaces.
D. Concealed spaces that do not contain fuel-fired equipment.

Slide 4-25

RESIDENTIAL SPRINKLERS

Control mode:

- Intended to control fire growth (prevent flashover) in the space where fire starts long enough for people to escape or allow suppression forces to conduct rescue and firefighting operations.



Slide 4-26

C. Sprinklers in the dwelling unit shall be listed for residential applications.

1. Residential sprinklers are intended to control fire growth (flashover) in the space where fire starts. They are required in the dwelling unit portion of the building.

2. Commercial-type sprinklers are intended to control a fire until the fire department arrives and extinguishes it. They should be used in dwelling areas not used for living purposes that may be sprinklered (e.g., attics, garages, attached storage spaces, retail stores, offices, etc.).

RESIDENTIAL SPRINKLERS (cont'd)

- Shall be listed by Underwriters Laboratories (UL) or other agency for residential use.
  - Bear mark "Residential Sprinkler" or "RES SPKR."
  - Operational range 135 to 170 F in most occupied spaces.
  - May be exposed or concealed.



Slide 4-27

3. Residential sprinklers are tested to Underwriters Laboratories (UL) 1626, *Standard for Residential Sprinklers for Fire-Protection Service*, to verify that they:

RESIDENTIAL SPRINKLERS (cont'd)

- Response Time Index (RTI).
- Water distribution pattern.



Slide 4-28

   a. Operate within the requirements of their Response Time Index (RTI).

   b. Have operating temperature ranges:

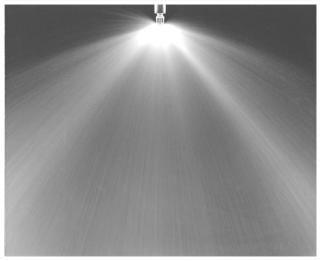
- Ordinary temperature: 135 to 170 F (57 to 77 C).
- Intermediate temperature: 175 to 225 F (79 to 107 C).

c. Distribute water in a flat pattern to wet the walls and ceilings of the space where the fire occurs.

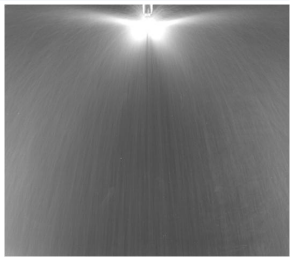
4. Residential sprinklers may be used only on wet pipe systems unless specifically listed for others.

5. Residential sprinklers should be installed only under smooth, flat ceilings unless their listing information allows different configurations.

WATER DISTRIBUTION PATTERN



Control mode: property protection.



Control mode: residential.

Courtesy: Tyco Fire Suppression & Building Products.

Slide 4-29

6. Property protection sprinklers are tested to UL 199, *Standard for Automatic Sprinklers for Fire-Protection Service*, to verify that they distribute water in an **umbrella-shaped** pattern to spray water over the combustible materials in the space where the fire occurs.

WATER DISTRIBUTION PATTERN (cont'd)

Property protection example.



Slide 4-30

D. Manufacturer's catalog information sheet.

1. May also be called cut sheet, technical bulletin, product literature or similar name.

2. Page one provides general product information.

a. Manufacturer's contact information.

b. Sprinkler model number or name.

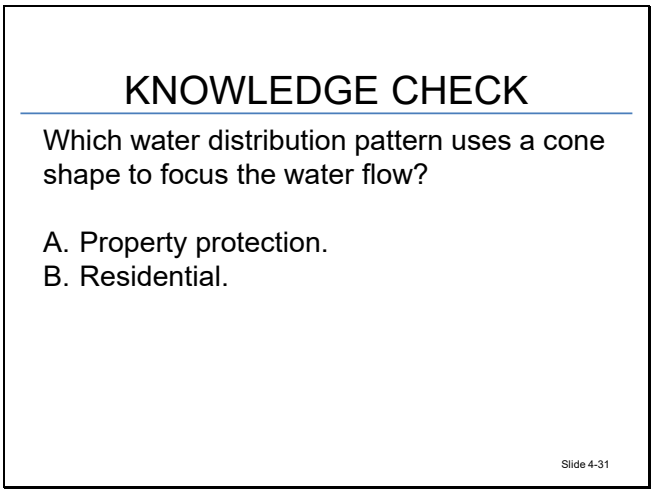
c. General product description and application.

- Short explanation of what the product is.

- Limits on when and where the sprinkler may be installed.

- Product characteristics, such as K-factor, orientation, concealment or accessories.

d. Product warnings and limitations on use.



SPRINKLER IDENTIFICATION NUMBER

- Sprinkler manufacturer's proprietary five- or six-character identification for:
  - Manufacturer.
  - K-factor.
  - Application (use).
  - Response characteristics.

Slide 4-32

e. Sprinkler Identification Numbers (SINs).

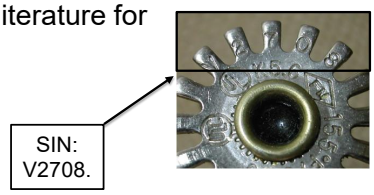
- Sprinklers are identified by their SIN.

- Since 2001, sprinkler manufacturers have used proprietary five- or six-character identification numbers.

- The SIN indicates the manufacturer (usually the first letter), K-factor, application (use) and response characteristics.

SPRINKLER IDENTIFICATION NUMBER (cont'd)

- Refer to manufacturer's technical literature for guidance.

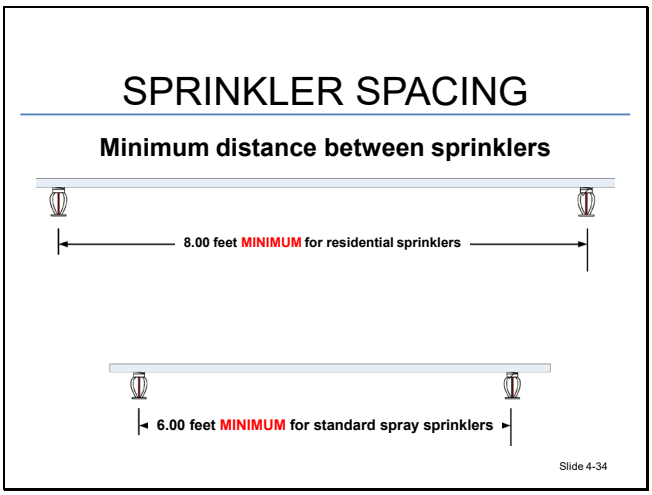


Slide 4-33

3. Page two provides technical data pertaining to coverage areas, listing information and design criteria.

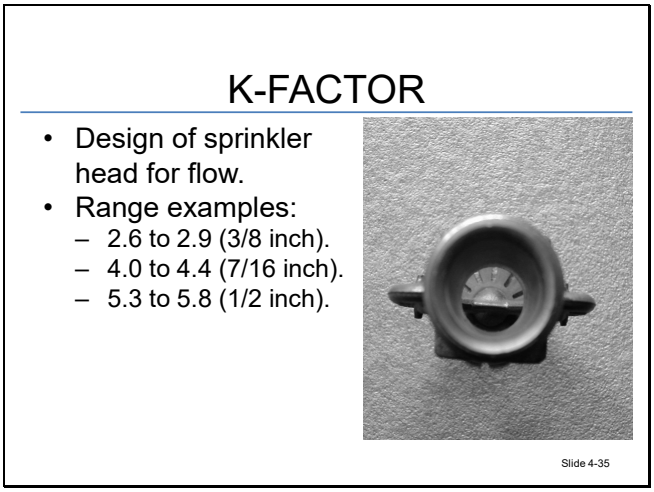
   a. Maximum coverage area.

      - Maximum coverage areas to assure water spray discharge pattern meets listing requirements.



b. Maximum spacing.

- Maximum straight line, point-to-point distances between sprinklers.
- This ensures water-spray overlap.
- Minimum flow and pressure requirements for various configurations.



c. Design criteria.

- Limits on system types.
- Details for hydraulic design.
- Obstructions and sensitivity factors.

4. Page three provides product illustration and installation details.

5. Page four provides placement details in relation to beamed ceilings.

6. Pages five and six illustrate beam and soffit obstructions and configurations.

7. Page six includes details for the sprinkler fitter and how to care for and maintain the sprinklers, as well as providing warranty and ordering information.

ORIENTATION/SYMBOLS

- Residential sprinklers may be installed upright, pendent or sidewall. Pendent may be concealed beneath listed cover plates.
- All sprinklers shall be installed in accordance with their listings.
- Refer to the manufacturer's technical literature for guidance.

Slide 4-36

E. Sprinkler orientation.

1. Residential sprinklers may be installed upright, pendent or sidewall. Pendent may be concealed beneath listed cover plates.

2. All sprinklers shall be installed in accordance with their listings.

3. Refer to the manufacturer's technical literature for installation guidance.

ORIENTATION/SYMBOLS (cont'd)

- Sprinklers are symbolized on plans by circles or triangles.
- Circles = upright or pendent sprinklers.
- Triangles = sidewall sprinklers.
  - The wider dimension is the flow direction.

SPRINKLER LEGEND

MFG	SYM	ORIF	THD	TEMP	TYPE	MODEL	FINISH	SIN #	RESP	ESCUTCHEON / NOTES
TYCO	◉	7/16	½"	155°	PENDENT	LF-II	WHITE	TY2234	RES	NO ESCUTCHEON / MAX SPACING: 18' x 18'
TYCO	◁	7/16	½"	155°	HORIZ SW	LF-II	WHITE	TY2334	RES	NO ESCUTCHEON / MAX SPACING: 16' x 16'

Slide 4-37

F. Sprinkler symbols.

1. Sprinklers are typically identified on a set of plans by circles or triangles.

   a. Circles represent upright or pendent sprinklers.

   b. Triangles represent sidewall sprinklers. The wider dimension is the flow direction.

2. Refer to the sprinkler legend on the plans for details pertaining to the type of sprinklers that will be installed.

3. The sprinkler legend usually includes:

   a. Sprinkler symbol.

   b. Orifice size and/or K-factor.

   c. Operating temperature rating.

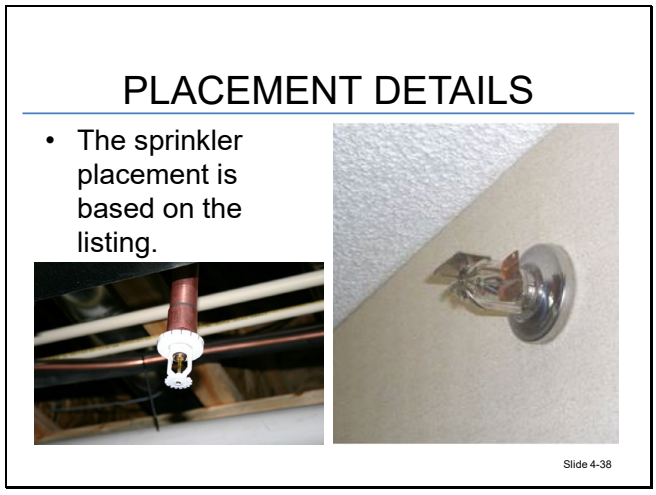
   d. Sprinkler orientation: upright, pendent, sidewall.

   e. Manufacturer, make and model.

   f. SIN.

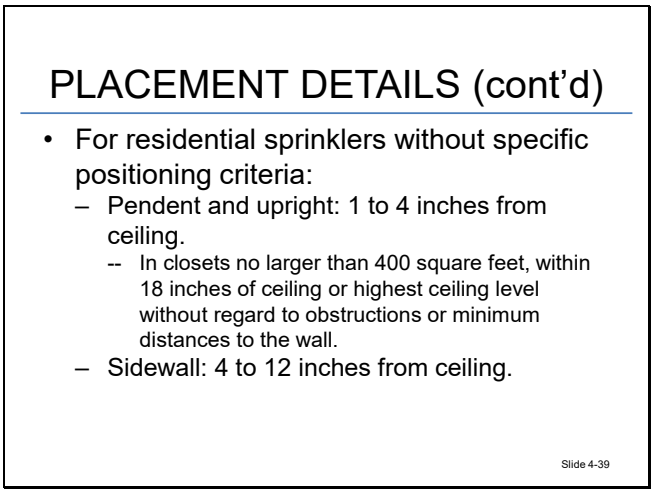
   g. Response characteristics — residential or commercial.

   h. Number of the make and model to be installed.



G. Sprinkler placement.

1. Sprinklers that have been listed with specific positioning criteria are to be positioned in accordance with their listing.



2. Residential pendent and upright sprinklers.

   a. Pendent and upright sprinklers that have not been listed with specific positioning criteria should be positioned so that the deflectors are within 1 to 4 inches from the ceiling.

   b. Pendent and upright sprinklers in closets are to be installed within 18 inches of the ceiling in order to avoid obstructions near the ceiling.

3. Residential sidewall sprinklers that have not been listed with specific positioning criteria should be positioned so that the deflectors are 4 to 12 inches from the ceiling.

4. In basements where ceilings are not required for the protection of piping, or where metallic pipe is installed, residential sprinklers shall be permitted to be positioned in a manner that anticipates future installation of a finished ceiling.

5. Nonresidential sprinklers shall be positioned in accordance with the positioning criteria specified by NFPA 13.

KNOWLEDGE CHECK

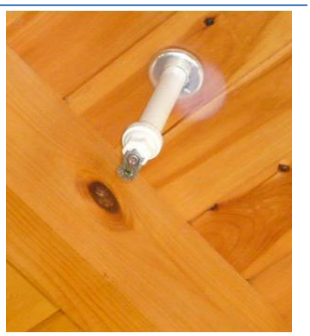
The SIN identifies which of the following? (Select all that apply.)

A. Application.
B. Manufacturer.
C. Response characteristics.
D. K-factor.

Slide 4-40

OBSTRUCTIONS

- Noncontinuous:
  - Hanging light fixtures.
  - Ceiling fans.
- Continuous:
  - Cabinets.
  - Beams.
  - Soffits.



Slide 4-41

6. Obstructions.

   a. Obstructions in the ceiling create challenges that can dramatically affect system performance and water-spray discharge patterns.

      - Obstructions are categorized as **noncontinuous** or **continuous.**

      - **Noncontinuous** include items such as hanging light fixtures, ceiling fans and chandeliers.

      - **Continuous** include cabinets, beams and soffits.

OBSTRUCTIONS (cont'd)



Slide 4-42

PENDENT: NONCONTINUOUS

Pendent: minimum 3 feet from center of obstruction.



Slide 4-43

b. Pendent sprinklers shall be located at least 3 feet away from obstructions, such as ceiling fans and light fixtures.

- The distance shall be measured from the center of the sprinkler to the center of the obstruction.

- Where the area of the fan blades encompasses more than 50% of the area of the plan view, an additional sprinkler shall be located on the other side of the obstruction.

- Where the sprinkler cannot be located 3 feet away from the obstruction (as measured from the center of the obstruction), an additional sprinkler shall be located on the other side of the obstruction.

CLOSETS



Slide 4-44

- In all closets not larger than 400 cubic feet, including those closets housing mechanical equipment, a single sprinkler at the highest ceiling space in the closet shall be sufficient without regard to obstructions.

SIDEWALL: NONCONTINUOUS

Sidewall: minimum 5 feet from center of obstruction.



Slide 4-45

c. Sidewall sprinklers shall be located at least 5 feet away from obstructions, such as ceiling fans and light fixtures.

- The distance shall be measured from the center of the sprinkler to the center of the obstruction.

- Where the area of the fan blades encompasses more than 50% of the space area of the plan view, an additional sprinkler shall be installed on the other side of the obstruction.

- Where the sprinkler cannot be located 5 feet away from the obstruction (as measured to the center of the obstruction), an additional sprinkler shall be installed on the other side of the obstruction.

KNOWLEDGE CHECK

Identify all continuous obstructions. (Select all that apply.)

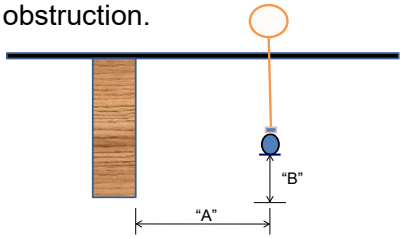
A. Soffits.
B. Ceiling fans.
C. Cabinets.
D. Beams.

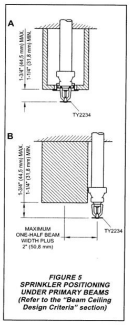
Slide 4-46

CONTINUOUS OBSTRUCTIONS

Deflector position for obstructions.

- A/B rule.
- Maximum distance above obstruction.





Slide 4-47

d. Continuous obstructions.

- Sprinklers shall be positioned so the water spray will not be compromised.

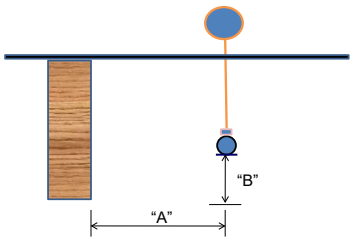
- NFPA 13D uses tables to determine:

  -- Distance from the sprinkler to the nearest side of the obstruction (A).

  -- Maximum allowable distance of deflector above bottom of obstruction (B).

CLEARANCE ABOVE OBSTRUCTION

A	B
Less than 12 inches	0
12-18	2 1/2
18-24	3 1/2
24-30	5 1/2
30-36	7 1/2
36-42	9 1/2
42-48	12
48-54	14
54-60	16 1/2
66-72	18



From NFPA 13, *Standard for the Installation of Sprinkler Systems*. Illustration only: Varies by sprinkler type.

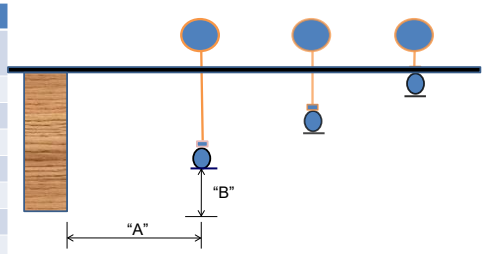
Slide 4-48

Distance from Sprinklers to Side of Obstruction (A)	Maximum Allowable Distance of Deflector Above Bottom of Obstruction (B) (inches)
Less than 1 ft.	0
1 ft. to less than 1 ft. 6 in.	0
1 ft. 6 in. to less than 2 ft.	1
2 ft. to less than 2 ft. 6 in.	1
2 ft. 6 in. to less than 3 ft.	1
3 ft. to less than 3 ft. 6 in.	3
3 ft. 6 in. to less than 4 ft.	3
4 ft. to less than 4 ft. 6 in.	5
4 ft. 6 in. to less than 5 ft.	7
5 ft. to less than 5 ft. 6 in.	7
5 ft. 6 in. to less than 6 ft.	7
6 ft. to less than 6 ft. 6 in.	9
6 ft. 6 in. to less than 7 ft.	11
7 ft. and greater	14

Used with permission from NFPA 13D and 13R, Copyright 2019 National Fire Protection Association.

CLEARANCE ABOVE OBSTRUCTION (cont'd)

A	B
Less than 12 inches	0
12-18	2 1/2
18-24	3 1/2
24-30	5 1/2
30-36	7 1/2
36-42	9 1/2
42-48	12
48-54	14
54-60	16 1/2
66-72	18

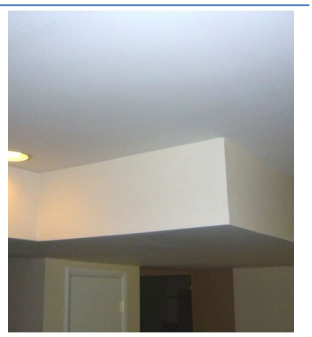


From NFPA 13. Illustration only: Varies by sprinkler type.

Slide 4-49

SOFFITS

If it is more than 8 inches wide or a projection from the wall, install the sprinkler below the soffit.



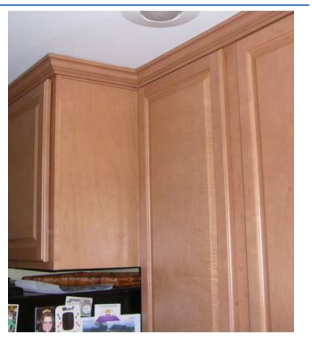
Slide 4-50

H. Soffits and cabinets.

1. Where soffits exceed more than 8 inches in width or projection from the wall, sprinklers shall be installed under the soffit.

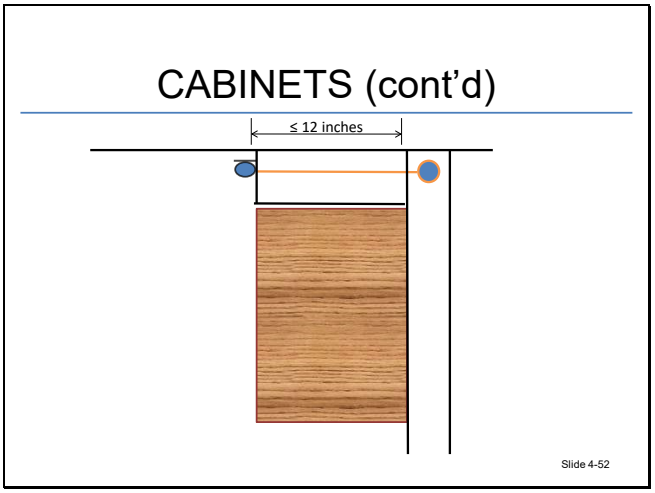
CABINETS

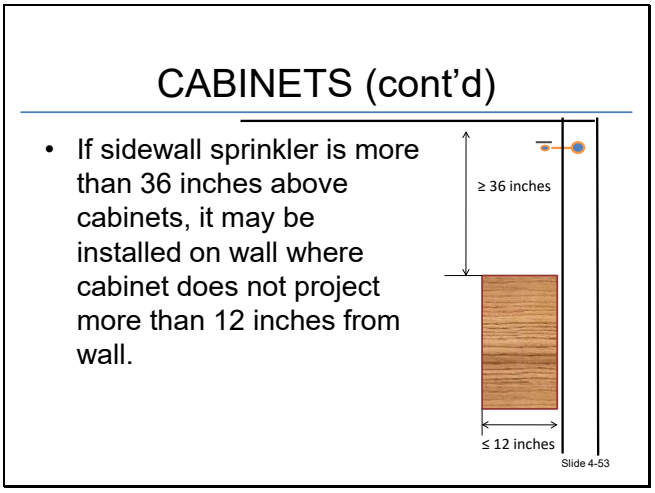
- Sidewall sprinkler may be installed in soffit face directly above cabinets where soffit does not project more than 12 inches from wall.



Slide 4-51

2. Sidewall sprinklers may be installed in the face of a soffit located directly over cabinets without requiring additional sprinklers below the soffit or cabinets where the soffit does not project horizontally more than 12 inches from the wall.

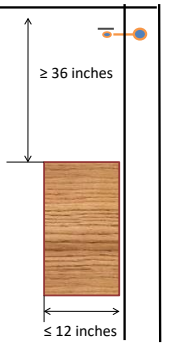




3. Where sidewall sprinklers are more than 3 feet above the top of cabinets, the sprinkler may be installed on the wall above the cabinets where the cabinets are not greater than 12 inches from the wall.

CABINETS (cont'd)

- NFPA 13D committee does not expect or require to have sprinklers installed under cabinets.



Slide 4-54

KNOWLEDGE CHECK

What standard does not require sprinklers to be installed under cabinets?

A. NFPA 13.
B. NFPA 13R.
C. NFPA 13D.
D. IRC P2904.

Slide 4-55

ORDINARY TEMPERATURE REQUIRED

- 135 to 170 F (57 to 77 C).
- Unless:
  - Maximum ambient ceiling temperature is greater than 100 F (38 C).

Slide 4-56

I. Use of ordinary temperature sprinklers (135 to 170 F (57 to 77 C)) is required throughout.

1. Unless maximum ambient ceiling temperature is greater than 100 F (38 C).

INTERMEDIATE TEMPERATURE RANGES (175 to 225 F)

Heat Source	Range (inches)
Fireplace, side of open or recessed	12 to 36
Fireplace, front of recessed	36 to 60
Coal or wood stove	12 to 42
Kitchen range top	9 to 18
Oven	9 to 18
Vent or chimney connector	9 to 18
Uninsulated heat duct	9 to 18
Uninsulated hot water pipe	6 to 12
Side of ceiling or wall warm air register	12 to 24
Front of wall warm air register	18 to 36
Water heater, furnace or boiler	3 to 6
Luminaire up to 250 watts	3 to 6
Luminaire 250 to 499 watts	6 to 12

Slide 4-57

INTERMEDIATE TEMPERATURE REQUIRED

- Specific locations:
  - Attics or glass/plastic skylights.
  - Concealed spaces beneath roof.
  - In range of heat-producing equipment (NFPA 13D).



Slide 4-58

INTERMEDIATE TEMPERATURE REQUIRED (cont'd)



Slide 4-59

2. Specific locations:

   a. Attics.

b. Glass or plastic skylights.

c. Concealed spaces directly beneath a roof.

d. Within influence of heat-producing equipment listed in NFPA 13D. (See Appendix B: Distances from Heat-Producing Elements in this unit.)

KNOWLEDGE CHECK

What is the intermediate temperature range?

A. 175 to 220 F.
B. 165 to 235 F.
C. 175 to 225 F.
D. 170 to 225 F.

Slide 4-60

ACTIVITY 4.1

Sprinkler Installation, Omissions and Configurations

Purpose

Identify locations where the sample drawings omit sprinkler protection, and identify sprinkler pipe configurations and details on a set of plans.

Directions

Refer to the Purple House drawings in Unit 1: Design and Installation Standards, Appendix A: Overall Plan for the Purple House Residential Sprinkler System, and answer the following questions.

1. Where have sprinklers been omitted in accordance with national standards?

2. How many sprinklers and what type of sprinklers are installed in the first-floor bathroom?

3. How many and what type of sprinklers are installed in the second-floor bedroom nearest the riser at the top of the page?

4. How many sprinklers are installed in the basement?

5. What is the temperature rating of the sprinklers installed in the kitchen?

_____

_____

_____

6. The layout of this sprinkler system is a:

   a. grid.
   b. tree.
   c. loop.
   d. network.

7. The pipe used in this sprinkler system will be:

   a. iron.
   b. copper.
   c. CPVC.
   d. PEX.

8. The basement is protected by a dry pipe system.

   a. True.
   b. False.

9. On the 1-inch pipe employed in this system, the maximum spacing between hangers is:

   a. 12 feet.
   b. 10 feet.
   c. 6 feet.
   d. 3 feet, 9 inches.

10. On the 1-inch pipe employed in this system, the maximum spacing between restraints and the last sprinkler on a branch line is:

    a. 9 inches.
    b. 12 inches.
    c. 16 inches.
    d. 24 inches.

QUICK COMPARISON

	NFPA 13	NFPA 13R	NFPA 13D/IRC P2904
Scope	All occupancies	Group R to four stories and 60 feet in height	One- and two-family and townhouses
Coverage	Entire building	Occupied spaces	Occupied spaces
Sprinkler design	Control mode, pipe schedule, hydraulic design, minimum 0.1 gallons per minute (gpm)/square foot	Life-safety control mode, four-head design, or 0.05 gpm/square foot	Life-safety control mode, two-head design, or 0.05 gpm/square foot
Sprinklers	All approved types, residential in dwelling unit and adjacent corridor	Residential in dwelling unit and adjacent corridor, other approved types elsewhere	Residential in dwelling unit, other approved types elsewhere
Water demand	System, plus 100 to 500 gpm	± 52 gpm	± 26 gpm
Duration	30 to 120 minutes	30 minutes	7 to 10 minutes
Fire Department Connection (FDC)	Yes, with some exceptions	Yes, if > 2,000 square feet or > one story	Optional

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III. SUMMARY

FEMA

U.S. Fire Administration

SUMMARY

- Sprinkler system configurations: tree, loop, grid and network.
- Permitted sprinkler omissions.
- Hangers and restraints.
- Residential sprinklers: difference with commercial sprinklers.

Slide 4-63

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REFERENCES

NFPA. (2016). *Standard for the installation of sprinkler systems*. (Standard No. 13). Retrieved from www.nfpa.org

NFPA. (2019). *Standard for the installation of sprinkler systems in low-rise residential occupancies*. (Standard No. 13R). Retrieved from www.nfpa.org

NFPA. (2019). *Standard for the installation of sprinkler systems in one- and two-family dwellings and manufactured homes*. (Standard No. 13D). Retrieved from www.nfpa.org

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APPENDIX A

SPRINKLER PERFORMANCE CHARACTERISTICS

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Sprinkler Performance Characteristics

Sprinklers are divided into two categories; control mode and suppression mode. This categorization is determined by the mechanism by which sprinklers are intended to attack fires.

Control mode sprinklers are designed to rely on cooling and pre-wetting. As the fire continues to burn in the area of ignition, the sprinkler controls roof/ceiling temperatures and prevents the spread of the fire until firefighters arrive or the fire burns itself out. Control mode sprinkler protection is characterized by a relatively large number of operating sprinklers (15 to 50 sprinklers). Residential sprinklers are included in the control mode category. Generally, in residential applications, the maximum number of sprinklers in a single compartment (room) is four.

Suppression mode sprinklers rely on thermal plume penetration to quickly stop fire growth. This reduces the heat release dramatically. Typically, the number of operating sprinklers is no more than six. Suppression mode sprinklers are used in high-challenge environments, such as high-piled or rack storage warehouses.

A good source for locating fire protection equipment is the Underwriters Laboratories (UL) Fire Protection Equipment Directory at www.ul.com/tools-apps-and-databases. This directory provides guidance and general information, such as manufacturer's listing information, temperature ratings, and sprinkler types and applications.

Guidance for sprinkler positions is determined by the following: the style of sprinkler used; listing criteria; room use; the presence of obstructions, such as beams, fan blades, light fixtures, etc.; soffits and cabinets; and the ceiling configuration. Obstructions should have no effect on sprinkler response time or sprinkler discharge. An additional consideration is the relationship of the sprinkler and any heat source, such as fireplaces, coal or wood burning stoves, kitchen range/wall ovens, uninsulated heat ducts or hot water pipes, hot air flues or hot air diffusers, and the hot water heater or furnace.

Historically, control mode sprinklers were developed to detect, control and confine a fire. Sprinklers today are designed for life safety, early suppression and special hazards. It is important to understand both the sprinkler and its application in order to design effective sprinkler protection.

Sprinklers apply water directly to burning materials during the incipient phase of the fire. This prevents fire growth and the production of excessive heat, smoke and toxic gases. Sprinklers maintain a survivable atmosphere in the room of origin.

The selection of sprinklers used in the design can vary based on performance and design of the sprinkler head. Residential sprinklers are found under the UL product category VKKW. They are labeled Residential or RES SPKR and have an operational range of 155 to 170 F (68 to 77 C). They may be exposed or concealed.

There are two things that make residential sprinklers different from property protection sprinklers. Their Response Time Index (RTI) and wall-wetting characteristics.

Response Time Index

RTI is a measure of the sensitivity of the sprinkler's thermal element. Sample sprinklers are plunged into a heated airstream and shall operate within eight to 10 seconds of reaching their rated temperature.

The RTI is calculated using the following:

- Operating time of the sprinkler.
- Operating temperature of the sprinkler's heat-responsive element.
- Air temperature of the test oven.
- Air velocity of the test oven.
- Sprinkler's conductivity *(c)* factor, a measure of conductance between the sprinkler's heat-responsive element and the sprinkler oven mount.

Residential or fast response sprinklers have a thermal element with an RTI of 50 (meters-seconds)$^{1/2}$ or less.

Standard response sprinklers have a thermal element with an RTI of 80 (meters-seconds)$^{1/2}$ or more.

Water Distribution Characteristics

When operated, property protection sprinklers discharge a cone- or umbrella-shaped pattern. This cone or umbrella is designed to soak adjacent combustible material to keep a fire from spreading.

- 18 inches below the sprinkler, the water distribution pattern shall be 4 feet in diameter.
- Four feet below the sprinkler, the water distribution pattern shall be 8 feet in diameter.

Residential sprinklers are designed with a flat spray distribution pattern. When they operate, all building surfaces within 28 inches of the ceiling shall get wet. This shape cools the thermal plume and ceiling jet to prevent flashover.

Residential sprinklers should be installed in accordance with their listing. The positioning details of the selected sprinkler type determine spacing, orientation and clearance from obstructions.

APPENDIX B

DISTANCES FROM HEAT-PRODUCING ELEMENTS

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Distances from Heat-Producing Elements

Sprinklers having an intermediate temperature rating (175 to 225 F (79 to 107 C)) should be installed in these areas.

No sprinklers should be located less than the minimum range.

Ordinary temperature sprinklers, 135 to 155 F (57 to 68 C), may be located outside the maximum range.

Heat Source	Range (inches)
Fireplace, side of open or recessed	12 to 36
Fireplace, front of recessed	36 to 60
Coal or wood stove	12 to 42
Kitchen range top	9 to 18
Oven	9 to 18
Vent or chimney connector	9 to 18
Uninsulated heat duct	9 to 18
Uninsulated hot water pipe	6 to 12
Side of ceiling or wall warm air register	12 to 24
Front of wall warm air register	18 to 36
Water heater, furnace or boiler	3 to 6
Luminaire up to 250 watts	3 to 6
Luminaire 250 to 499 watts	6 to 12

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APPENDIX C

TYCO SERIES II SPRINKLER MANUFACTURER'S LITERATURE

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tyco / Fire & Building Products

Technical Services: Tel: (800) 381-9312 / Fax: (800) 791-5500

Series TY-B — 5.6 K-factor Horizontal and Vertical Sidewall Sprinklers Standard Response, Standard Coverage

General Description

The Series TY-B, 5.6 K-factor, Horizontal and Vertical Sidewall Sprinklers described in this data sheet are standard response - standard coverage, decorative 5 mm glass bulb type spray sprinklers designed for use in light and ordinary hazard, commercial occupancies such as banks, hotels, shopping malls, etc. They are designed for installation along a wall or the side of a beam and just beneath a smooth ceiling. Sidewall sprinklers are commonly used instead of pendent or upright sprinklers due to aesthetics or building construction considerations, where piping across the ceiling is not desirable.

The recessed version of the Series TY-B Horizontal Sidewall Sprinkler is intended for use in areas with a finished wall. It uses a two-piece Style 10 Recessed Escutcheon. The Recessed Escutcheon provides 1/2 inch (12,7 mm) of recessed adjustment or up to 3/4 inch (19,1 mm) of total adjustment from the flush sidewall position. The adjustment provided by the Recessed Escutcheon reduces the accuracy to which the fixed pipe nipples to the sprinklers must be cut.

IMPORTANT

Always refer to Technical Data Sheet TFP700 for the "INSTALLER WARNING" that provides cautions with respect to handling and installation of sprinkler systems and components. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in a fire situation or cause it to operate prematurely.

Corrosion resistant coatings, where applicable, are utilized to extend the life of copper alloy sprinklers beyond that which would otherwise be obtained when exposed to corrosive atmospheres. Although corrosion resistant coated sprinklers have passed the standard corrosion tests of the applicable approval agencies, the testing is not representative of all possible corrosive atmospheres. Consequently, it is recommended that the end user be consulted with respect to the suitability of these coatings for any given corrosive environment. The effects of ambient temperature, concentration of chemicals, and gas/chemical velocity, should be considered, as a minimum, along with the corrosive nature of the chemical to which the sprinklers will be exposed.

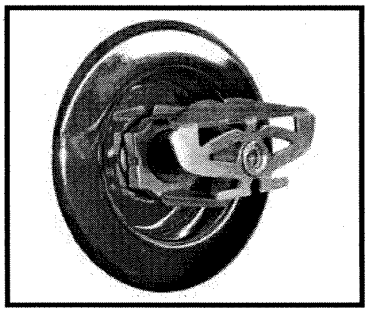
WARNINGS

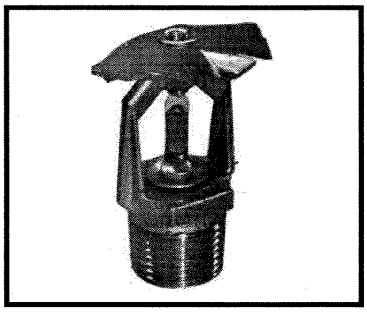
The Series TY-B Sprinklers described herein must be installed and maintained in compliance with this document, as well as with the applicable standards of the National Fire Protection Association, in addition to the standards of any other authorities having jurisdiction. ***Failure to do so may impair the performance of these devices.***

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. The installing contractor or sprinkler manufacturer should be contacted with any questions.

Model/Sprinkler Identification Numbers

TY3351 - Horizontal
TY3451 - Vertical





Technical Data

Approvals
UL and C-UL Listed.
FM, LPCB, and NYC Approved.
(Refer to Table A for complete approval information including corrosion resistant status)

Maximum Working Pressure
Refer to Table B.

Discharge Coefficient
K = 5.6 GPM/psi$^{1/2}$ (80,6 LPM/bar$^{1/2}$)

Temperature Ratings
Refer to Table A.

Finishes
Sprinkler: Refer to Table A.
Recessed Escutcheon: White Coated, Chrome Plated, and Brass Plated.

K	TYPE	TEMP.	BULB LIQUID	SPRINKLER FINISH (See Note 10)					
				NATURAL BRASS	CHROME PLATED	WHITE*** POLYESTER	LEAD COATED	WAX COATED	WAX OVER LEAD COATED
5.6 1/2" NPT	HORIZ. SIDEWALL (TY3351)	135°F/57°C	Orange	1, 2, 3, 4, 9		1, 2, 3, 9	1, 2, 3, 9	1, 2, 3, 9	1, 2, 3, 9
		155°F/68°C	Red						
		175°F/79°C	Yellow						
		200°F/93°C	Green						
		286°F/141°C	Blue					1**, 2**, 3**, 9**	1**, 2**, 3**, 9**
		360°F/182°C	Mauve	1, 2, 4, 9		1, 2, 9		N/A	
	RECESSED HORIZ. SIDEWALL (TY3351)* Figure 3	135°F/57°C	Orange	1, 2, 3, 9			N/A		
		155°F/68°C	Red						
		175°F/79°C	Yellow						
		200°F/93°C	Green						
5.6 1/2" NPT	VERTICAL SIDEWALL (TY3451) Installed Pendent or Upright	135°F/57°C	Orange	4, 5, 6, 7, 8, 9			5, 6, 7, 9	5, 6, 7, 9	5, 6, 7, 9
		155°F/68°C	Red						
		175°F/79°C	Yellow						
		200°F/93°C	Green						
		286°F/141°C	Blue					5**, 6**, 7**, 9**	5**, 6**, 7**, 9**
		360°F/182°C	Mauve	4, 5, 6, 8, 9				N/A	

NOTES:
1. Listed by Underwriters Laboratories, Inc. (UL) for use in Light and Ordinary Hazard Occupancies at a 4 to 12 inch (100 to 300 mm) top of deflector to ceiling distance.
2. Listed by Underwriters Laboratories, Inc. for use in Canada (C-UL) for use in Light and Ordinary Hazard Occupancies at a 4 to 12 inch (100 to 300 mm) top of deflector to ceiling distance.
3. Approved by Factory Mutual Research Corporation (FM) for use in Light Hazard Occupancies at a 4 to 12 inch (100 to 300 mm) top of deflector to ceiling distance.
4. Approved by the Loss Prevention Certification Board (LPCB Ref. No. 094a/05 & 007k/03) at a 4 to 6 inch (100 to 150 mm) deflector to ceiling distance.
5. Listed by Underwriters Laboratories, Inc. (UL) for use in Light and Ordinary Hazard Occupancies.
6. Listed by Underwriters Laboratories, Inc. for use in Canada (C-UL:) for use in Light and Ordinary Hazard Occupancies.
7. Approved by Factory Mutual Research Corporation (FM) for use in Light Hazard Occupancies.
8. Approved by the Loss Prevention Certification Board (LPCB Ref. No. 094a/05 & 007k/03).
9. Approved by the City of New York under MEA 354-01-E.
10. Where Polyester Coated, Lead Coated, Wax Coated, and Wax over Lead Coated Sprinklers are noted to be UL and C-UL Listed, the sprinklers are UL and C-UL Listed as Corrosion Resistant Sprinklers. Where Lead Coated, Wax Coated, and Wax over Lead Coated Sprinklers are noted to be FM Approved, the sprinklers are FM Approved as Corrosion Resistant Sprinklers.

* Installed with Style 10 (1/2" NPT) 3/4" Total Adjustment Recessed Escutcheon.
** 150°F/66°C Maximum Ceiling Temperature.
*** Frame and deflector only. Listings and approvals apply to color (Special Order).

TABLE A
LABORATORY LISTINGS AND APPROVALS

Physical Characteristics
Frame . . . . . Bronze
Button . . . . . Brass/Copper
Sealing Assembly . . . . . Beryllium Nickel w/Teflon†
Bulb . . . . . Glass
Compression Screw . . . . . Bronze
HSW Deflector . . . . . Bronze
VSW Deflector . . . . . Copper

Patents
U.S.A. 5,810,263

Operation

The glass Bulb contains a fluid which expands when exposed to heat. When the rated temperature is reached, the fluid expands sufficiently to shatter the glass Bulb, allowing the sprinkler to activate and water to flow.

Design Criteria

The Series TY-B Horizontal and Vertical Sidewall Sprinklers are intended for fire protection systems designed in accordance with the standard installation rules recognized by the applicable Listing or Approval agency (e.g., UL Listing is based on the requirements of NFPA 13, and FM Approval is based on the requirements of FM's Loss Prevention Data Sheets). Only the Style 10 Recessed Escutcheon is to be used for recessed horizontal installations.

† DuPont Registered Trademark

K	TYPE	SPRINKLER FINISH					
		NATURAL BRASS	CHROME PLATED	WHITE POLYESTER	LEAD COATED	WAX COATED	WAX OVER LEAD COATED
5.6 1/2" NPT	HORIZONTAL SIDEWALL (TY3351)	250 PSI (17,2 BAR) OR 175 PSI (12,1 BAR) (SEE NOTE 1)			175 PSI (12,1 BAR)		
	RECESSED HORIZ. SIDEWALL (TY3351)				N/A		
	VERTICAL SIDEWALL (TY3451)	175 PSI (12,1 BAR)					

NOTES:
1. The maximum working pressure of 250 psi (17,2 bar) only applies to the Listing by Underwriters Laboratories, Inc. (UL); the Listing by Underwriters Laboratories, Inc. for use in Canada (C-UL); and, the Approval by the City of New York.

TABLE B, MAXIMUM WORKING PRESSURE

Installation

The Series TY-B Sprinklers must be installed in accordance with the following instructions:

NOTES

Do not install any bulb type sprinkler if the bulb is cracked or there is a loss of liquid from the bulb. With the sprinkler held horizontally, a small air bubble should be present. The diameter of the air bubble is approximately 1/16 inch (1,6 mm) for the 135°F/57°C to 3/32 inch (2,4 mm) for the 360°F/182°C temperature ratings.

A leak tight 1/2 inch NPT sprinkler joint should be obtained with a torque of 7 to 14 ft.lbs. (9,5 to 19,0 Nm). A maximum of 21 ft. lbs. (28,5 Nm) of torque may be used to install sprinklers with 1/2 NPT connections. Higher levels of torque may distort the sprinkler inlet and cause leakage or impairment of the sprinkler.

Do not attempt to make-up for insufficient adjustment in the escutcheon plate by under- or over-tightening the sprinkler. Readjust the position of the sprinkler fitting to suit.

The **Series TY-B Horizontal and Vertical Sidewall Sprinklers** must be installed in accordance with the following instructions.

Step 1. Horizontal sidewall sprinklers are to be installed in the horizontal position with their centerline of waterway perpendicular to the back wall and parallel to the ceiling. The word "TOP" on the Deflector is to face towards the ceiling.

Vertical sidewall sprinklers are to be installed in the pendent or upright position with the arrow on the Deflector pointing away from the wall.

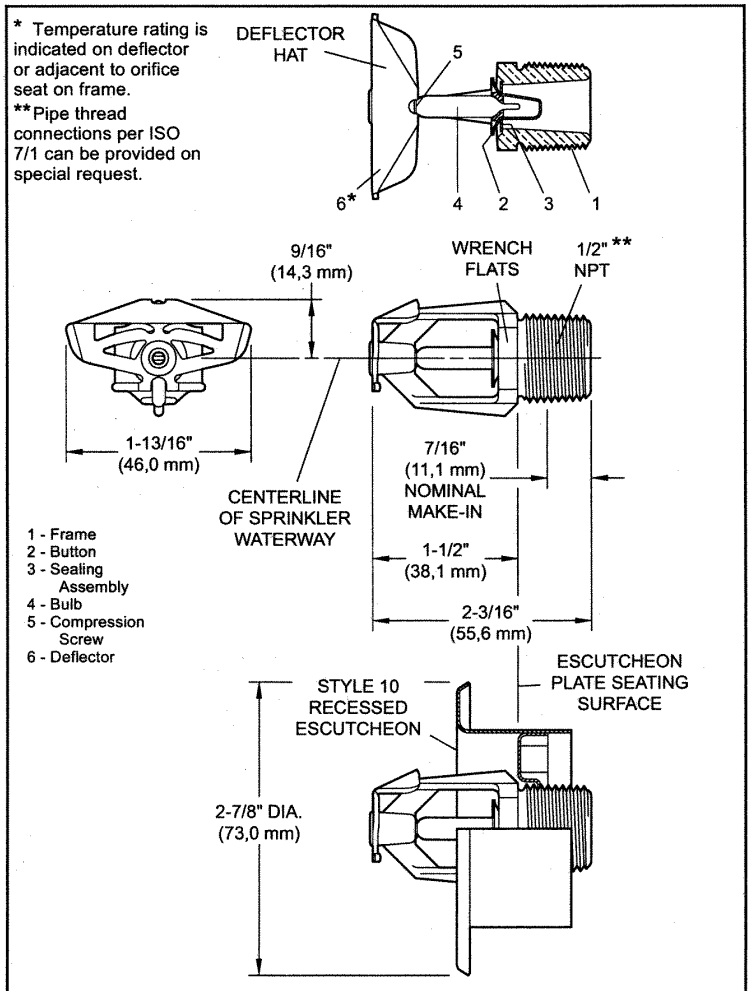


FIGURE 1
5.6 K-FACTOR STANDARD RESPONSE
SERIES TY-B HORIZONTAL SIDEWALL (TY3351) SPRINKLERS

Step 2. With pipe thread sealant applied to the pipe threads, hand tighten the sprinkler into the sprinkler fitting.

Step 3. Tighten the sprinkler into the sprinkler fitting using only the W-Type 6 Sprinkler Wrench (Ref. Figure 4), except that an 8 or 10 inch adjustable Crescent wrench is to be used for wax coated sprinklers. With reference to Figure 1 or 2, the W-Type 6 Sprinkler Wrench or the Crescent wrench, as applicable, is to be applied to the wrench flats.

When installing wax coated sprinklers with the adjustable Crescent wrench, additional care needs to be exercised to prevent damage to the wax coating on the sprinkler wrench flats or frame arms and, consequently, exposure of bare metal to the corrosive environment. The jaws of the wrench should be opened sufficiently wide to pass over the wrench flats without damaging the wax coating. Before wrench tightening the sprinkler, the jaws of the wrench are to be adjusted to just contact the sprinkler wrench flats. After wrench tightening the sprinkler, loosen the wrench jaws before removing the wrench.

After installation, the sprinkler wrench flats and frame arms must be inspected and the wax coating retouched (repaired) whenever the coating has been damaged and bare metal is exposed. The wax coating on the wrench flats can be retouched by gently applying a heated 1/8 inch diameter steel rod to the areas of wax that have been damaged, to smooth it back over areas where bare metal is exposed.

NOTES

Only retouching of the wax coating applied to the wrench flats and frame arms is permitted, and the retouching is to be performed only at the time of the initial sprinkler installation.

The steel rod should be heated only to the point at which it can begin to melt the wax, and appropriate precautions need to be taken, when handling the heated rod, in order to prevent the installer from being burned.

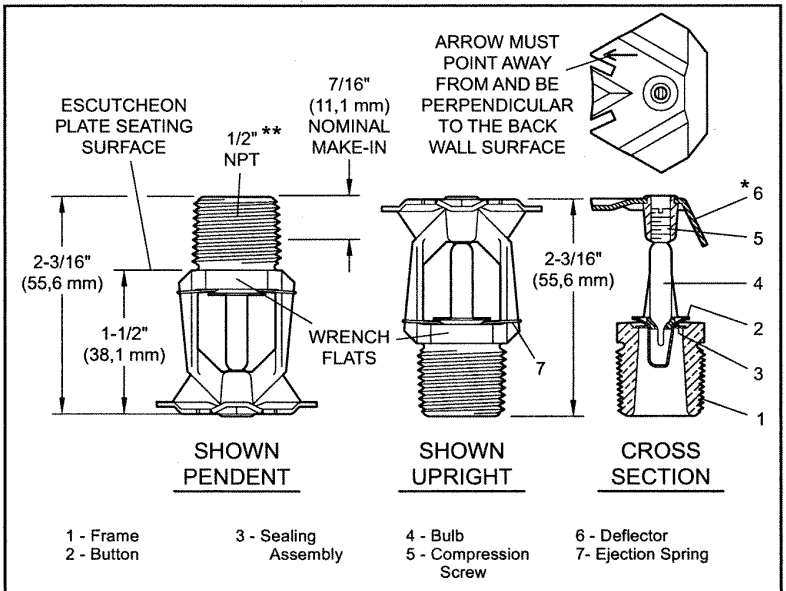
The **Series TY-B Recessed Horizontal Sidewall Sprinklers** must be installed in accordance with the following instructions.

Step A. Recessed horizontal sidewall sprinklers are to be installed in the horizontal position with their centerline of waterway perpendicular to the back wall and parallel to the ceiling. The word "TOP" on the Deflector is to face towards the ceiling.

Step B. After installing the Style 10 Mounting Plate over the sprinkler threads, hand tighten the sprinkler into the sprinkler fitting.

Step C. Tighten the sprinkler into the sprinkler fitting using only the W-Type 7 Recessed Sprinkler Wrench (Ref. Figure 5). With reference to Figure 1, the W-Type 7 Recessed Sprinkler Wrench is to be applied to the sprinkler wrench flats.

Step D. After the ceiling has been installed or the finish coat has been applied, slide on the Style 10 Closure over the Series TY-B Sprinkler and push the Closure over the Mounting Plate until its flange comes in contact with the ceiling.



* Temperature rating is indicated on deflector or adjacent to orifice seat on frame.
** Pipe thread connections per ISO 7/1 can be provided on special request.

FIGURE 2
5.6 K-FACTOR STANDARD RESPONSE
SERIES TY-B VERTICAL SIDEWALL (TY3451) SPRINKLERS

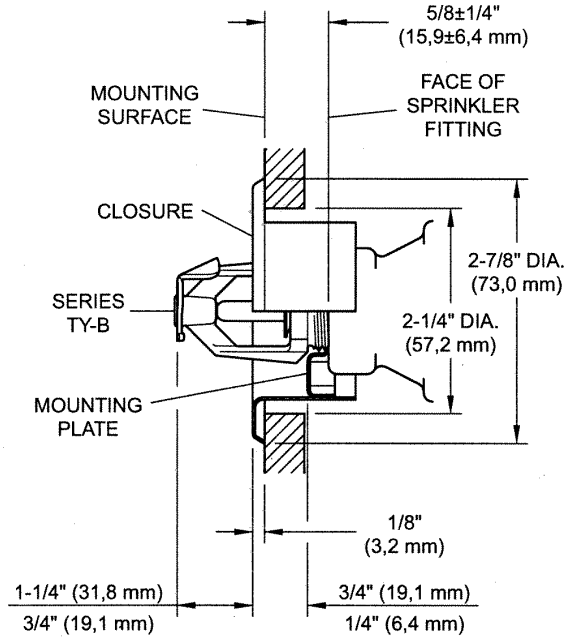


FIGURE 3
SERIES TY-B RECESSED HORIZONTAL SIDEWALL SPRINKLER WITH TWO-PIECE 3/4 INCH TOTAL ADJUSTMENT STYLE 10 RECESSED ESCUTCHEON

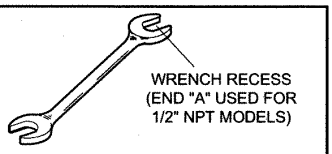


FIGURE 4
W-TYPE 6 SPRINKLER WRENCH

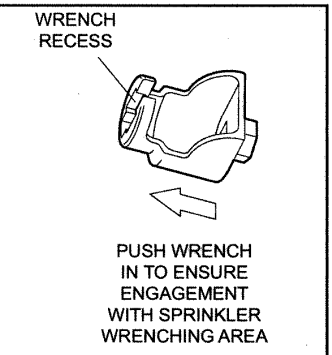


FIGURE 5
W-TYPE 7 RECESSED SPRINKLER WRENCH

Care and Maintenance

The Series TY-B Sprinklers must be maintained and serviced in accordance with the following instructions:

NOTES

Before closing a fire protection system main control valve for maintenance work on the fire protection system that it controls, permission to shut down the affected fire protection system must be obtained from the proper authorities and all personnel who may be affected by this action must be notified.

The owner must assure that the sprinklers are not used for hanging of any objects; otherwise, non-operation in the event of a fire or inadvertent operation may result.

Absence of an escutcheon, which is used to cover a clearance hole, may delay the time to sprinkler operation in a fire situation.

Sprinklers that are found to be leaking or exhibiting visible signs of corrosion must be replaced.

Automatic sprinklers must never be be painted, plated, coated or otherwise altered after leaving the factory. Modified sprinklers must be replaced. Sprinklers that have been exposed to corrosive products of combustion, but have not operated, should be replaced if they cannot be completely cleaned by wiping the sprinkler with a cloth or by brushing it with a soft bristle brush.

Care must be exercised to avoid damage to the sprinklers - before, during, and after installation. Sprinklers damaged by dropping, striking, wrench twist/slippage, or the like, must be replaced. Also, replace any sprinkler that has a cracked bulb or that has lost liquid from its bulb. (Ref. Installation Section).

Frequent visual inspections are recommended to be initially performed for corrosion resistant coated sprinklers, after the installation has been completed, to verify the integrity of the corrosion resistant coating. Thereafter, annual inspections per NFPA 25 should suffice; however, instead of inspecting from the floor level, a random sampling of close-up visual inspections should be made, so as to better determine the exact sprinkler condition and the long term integrity of the corrosion resistant coating, as it may be affected by the corrosive conditions present.

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable standards of the National Fire Protection Association (e.g., NFPA 25), in addition to the standards of any other authorities having jurisdiction. The installing contractor or sprinkler manufacturer should be contacted relative to any questions.

It is recommended that automatic sprinkler systems be inspected, tested, and maintained by a qualified Inspection Service in accordance with local requirements and/or national codes.

P/N 57 — XXX — X — XXX

	MODEL/SIN
578 HORIZONTAL SIDEWALL	TY3351
575 VERTICAL SIDEWALL	TY3451

	SPRINKLER
1	NATURAL BRASS
4	WHITE POLYESTER
3	WHITE (RAL9010)*
9	CHROME PLATED
7	LEAD COATED
6	WAX COATED 286°F/141°C MAX.
8	WAX OVER LEAD 286°F/141°C MAX.

	TEMPERATURE RATING
135	135°F/57°C
155	155°F/68°C
175	175°F/79°C
200	200°F/93°C
286	286°F/141°C
360	360°F/182°C

* Eastern Hemisphere sales only.

TABLE C
PART NUMBER SELECTION
SERIES TY-B HORIZONTAL AND VERTICAL SIDEWALL SPRINKLERS

Limited Warranty

Products manufactured by Tyco Fire & Building Products (TFBP) are warranted solely to the original Buyer for ten (10) years against defects in material and workmanship when paid for and properly installed and maintained under normal use and service. This warranty will expire ten (10) years from date of shipment by TFBP. No warranty is given for products or components manufactured by companies not affiliated by ownership with TFBP or for products and components which have been subject to misuse, improper installation, corrosion, or which have not been installed, maintained, modified or repaired in accordance with applicable Standards of the National Fire Protection Association, and/or the standards of any other Authorities Having Jurisdiction. Materials found by TFBP to be defective shall be either repaired or replaced, at TFBP's sole option. TFBP neither assumes, nor authorizes any person to assume for it, any other obligation in connection with the sale of products or parts of products. TFBP shall not be responsible for sprinkler system design errors or inaccurate or incomplete information supplied by Buyer or Buyer's representatives.

In no event shall TFBP be liable, in contract, tort, strict liability or under any other legal theory, for incidental, indirect, special or consequential damages, including but not limited to labor charges, regardless of whether TFBP was informed about the possibility of such damages, and in no event shall TFBP's liability exceed an amount equal to the sales price.

The foregoing warranty is made in lieu of any and all other warranties, express or implied, including warranties of merchantability and fitness for a particular purpose.

This limited warranty sets forth the exclusive remedy for claims based on failure of or defect in products, materials or components, whether the claim is made in contract, tort, strict liability or any other legal theory.

This warranty will apply to the full extent permitted by law. The invalidity, in whole or part, of any portion of this warranty will not affect the remainder.

Ordering Procedure

When placing an order, indicate the full product name. Refer to the Price List for complete listing of Part Numbers.

Contact your local distributor for availability.

Sprinkler Assemblies with NPT Thread Connections:
Specify: (Specify Model/SIN), Standard Response, (specify K-factor), (specify temperature rating), Series TY-B (specify Horizontal Sidewall or Vertical Sidewall) Sprinkler with (specify type of finish or coating), P/N (specify from Table C).

Recessed Escutcheon:
Specify: Style 10 Recessed Escutcheon with (specify*) finish, P/N (specify*).

* Refer to Technical Data Sheet TFP770.

Sprinkler Wrench:
Specify: W-Type 6 Sprinkler Wrench, P/N 56-000-6-387.

Specify: W-Type 7 Sprinkler Wrench, P/N 56-850-4-001.

APPENDIX D

TYCO SERIES LFII RESIDENTIAL SPRINKLER DESIGN GUIDE

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tyco Fire Protection Products

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Series LFII Residential Sprinkler Design Guide

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General Description

Tyco Fire Protection Products (TFPP) Residential Sprinklers are a type of fast-response automatic sprinklers. They are to be used only in wet or dry pipe residential sprinkler systems for one-and two-family dwellings and mobile homes per NFPA 13D; wet or dry pipe residential sprinkler systems for residential occupancies up to and including four stories in height per NFPA 13R; or, wet or dry pipe sprinkler systems for the residential portions of any occupancy per NFPA 13.

This document provides design guidance for the Series LFII Residential Sprinklers outlined in Table A.

Residential fire sprinkler systems should only be designed and installed by those competent and completely familiar with automatic sprinkler system design, installation procedures, and techniques. Several criteria may apply to a given installation and usage of each sprinkler. Consequently, the sprinkler system designer is recommended to review and develop a working understanding of the complete list of criteria prior to initiating the design of a residential fire sprinkler system.

NOTICE

The Series LFII Residential Sprinklers described herein must be installed and maintained in compliance with this document, as well as with the applicable standards of the National Fire Protection Association, in addition to the standards of any other authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. The installing contractor or sprinkler manufacturer should be contacted with any questions.

Design: Background

All Series LFII Residential Sprinklers are tested and listed under UL 1626 "Standard for Residential Sprinklers for Fire Protection Service" with specific published spacings, flows, and pressures for each residential sprinkler identified by its Sprinkler Identification Number (SIN) and as detailed in the Technical Data Sheets referenced in Table A.

The design criteria for Series LFII residential sprinklers contained in the current NFPA Standards must be followed except as modified by the individual UL 1626 listing information provided in the Technical Data Sheets referenced in Table A and this design guide.

NOTICE

The approval of all residential sprinkler designs and installations must be made by the authority having jurisdiction for compliance with all governmental codes and standards.

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Sprinkler Identification Number (SIN)	Type	K-factor	Technical Data Sheet Number
TY2234	Pendent and Recessed Pendent	4.9	TFP400
TY1234		3.0	TFP402
TY4234	Pendent, Recessed Pendent and Domed Plate Concealed Pendent	6.9	TFP408
TY1334	Horizontal Sidewall and Recessed Horizontal Sidewall	4.2	TFP410
TY2334		4.4	TFP412
TY3334		5.6	TFP415
TY4334		5.8	TFP417
TY2284	Flush Pendent	4.2	TFP420
TY2384	Flush Horizontal Sidewall	4.2	TFP425
TY3596	Flat Plate Concealed Pendent	4.9	TFP442
TY2234	Domed Plate Concealed Pendent	4.9	TFP450
TY2235	Dry Recessed Pendent	4.9	TFP460
TY2335	Dry Horizontal Sidewall and Recessed Horizontal Sidewall	4.4	TFP461

TABLE A
SERIES LFII RESIDENTIAL SPRINKLERS

Design: Hydraulics

NFPA 13D. The number of design sprinklers shall include all sprinklers within a compartment up to a maximum of two sprinklers where specific UL Listed flows are provided. The minimum required sprinkler flow rate for systems designed to NFPA 13D are given in the Technical Data Sheets referenced in Table A, as a function of temperature rating and the maximum allowable coverage areas.

NOTE: *For actual coverage areas less than or between those indicated in the Technical Data Sheets referenced in Table A, it is necessary to use the minimum required flow for the next largest coverage area.*

Example No. 1: Assuming the use of a pendent sprinkler, the actual coverage area being protected is 14 ft. x 16 ft. In this case the minimum flow requirement for a 16 ft. x 16 ft. coverage area must be used.

Example No. 2: Assuming the use of a pendent sprinkler, the actual coverage area being protected is 17 ft. x 17 ft. In this case the minimum flow requirement for a 18 ft. x 18 ft. coverage area must be used.

NFPA 13R. The number of design sprinklers shall include all sprinklers within a compartment up to a maximum of four sprinklers where specific UL Listed flows are provided. The minimum required sprinkler flow rate for systems designed to NFPA 13R are given in the Technical Data Sheets referenced in Table A, as a function of temperature rating and the maximum allowable coverage areas.

NOTE: *For actual coverage areas less than or between those indicated in the Technical Data Sheets referenced in Table A, it is necessary to use the minimum required flow for the next largest coverage area.*

Example 1: Assuming the use of a pendent sprinkler, the actual coverage area being protected is 14 ft. x 16 ft. In this case the minimum flow requirement for a 16 ft. x 16 ft. coverage area must be used.

Example 2: Assuming the use of a pendent sprinkler, the actual coverage area being protected is 17 ft. x 17 ft. In this case the minimum flow requirement for a 18 ft. x 18 ft. coverage area must be used.

NFPA 13. The number of design sprinklers is to be the four most hydraulically demanding sprinklers. The minimum required discharge from each of the four sprinklers is to be the greater of the following:

- The flow rates given in the Technical Data Sheets referenced in Table A for NFPA 13D and 13R as a function of temperature rating and the maximum allowable coverage area.

NOTE: *For actual coverage areas less than or between those indicated in the Technical Data Sheets referenced in Table A, it is necessary to use the minimum required flow for the next largest coverage area.*

- A minimum discharge of 0.1 gpm/ft². over the "design area" comprised of the four most hydraulically demanding sprinklers for the actual coverage areas being protected by the four sprinklers.

NOTE: *The greatest dimension of the actual coverage area cannot be any greater than the maximum coverage areas indicated in the Technical Data Sheets referenced in Table A.*

Example 1: A corridor being protected is 8 ft. wide; consequently, an actual coverage area of 8 ft. x 20 ft. is being contemplated. Based on using the LFII (TY2234) Pendent Residential Pendent Sprinkler, the flow rate provided in TFP400 for a 20 ft x 20 ft. coverage area is 20 gpm. However based on minimum discharge of 0.1 gpm/ft². the flow rate would be 16 gpm. In this case a minimum flow rate of 20 gpm for this design sprinkler must be utilized.

Example 2: A long narrow room being protected is 12 ft. wide; consequently, an actual coverage area of 12 ft. x 20 ft. is being contemplated. Based on using the LFII (TY2234) Pendent Residential Pendent Sprinkler, the flow rate provided in TFP400 for a 20 ft x 20 ft. coverage area is 20 gpm. However based on minimum discharge of 0.1 gpm/ft². the flow rate would be 24 gpm. In this case a minimum flow rate of 24 gpm for this design sprinkler must be utilized.

Compartment. A compartment is a space that is completely enclosed by walls and a ceiling. The compartment enclosure may have openings to an adjoining space, provided the openings have a minimum lintel depth of 8 inches from the ceiling.

Sloped Ceilings. For systems designed to NFPA 13, 13D, or 13R and where specific UL Listed flows have not been provided for sloped ceilings, consult with the local authority having jurisdiction with regard to the number of "design sprinklers" for sloped ceilings having a slope greater than a 2 inch rise for a 12 inch run.

Design: Sprinkler Location

When locating the Series LFII Residential Sprinklers, Sprinkler Spacing, Obstruction To Water Distribution, Heat Sensitivity, Preventing Cold Soldering, and Proximity To A Heat Source must all be considered.

Table B provides a conversion of "Rise Over Run" that is a conventional method of defining slope in architectural drawings to "Degrees Of Slope" as used in this guideline.

Sprinkler Spacing Under Horizontal Ceilings (Up to 9 degrees of slope). Residential sprinklers are utilized for various maximum spacings in accordance with minimum flows and pressures. Typical coverage areas for pendent sprinklers are 12 ft. x 12 ft. up to 20 ft. x 20 ft., and typical coverage areas for horizontal sidewall sprinklers are 12 ft. x 12 ft. up to 16 ft. x 20 ft. Refer to the Technical Data Sheets referenced in Table A for coverage areas, and refer to the applicable NFPA standard for Spacing Rules Under Horizontal Ceilings. Understanding the intended area of coverage while using this guide is critical.

Always remember that the spacing of sprinklers under horizontal ceilings with slopes greater than 0 degrees (i.e., non-level) is measured along the slope when determining distance off of walls and between sprinklers.

Sprinkler Spacing Under Sloped Ceilings (10 to a 60 degrees of slope). Residential sprinklers are utilized for various maximum spacings in accordance with minimum flows and pressures. Typical coverage areas for pendent sprinklers are 12 ft. x 12 ft. up to 20 ft. x 20 ft., and typical coverage areas for horizontal sidewall sprinklers are 12 ft. x 12 ft. up to 16 ft. x 20 ft. Refer to the Technical Data Sheets referenced in Table A for coverage areas, and refer to Figure 1 for Spacing Rules Under Sloped Ceilings. Understanding the intended area of coverage while using this guide is critical.

Always remember that the spacing of sprinklers under sloped ceilings is measured along the slope when determining distance off of walls and between sprinklers.

Obstruction to Water Distribution. Location with respect to obstructions to water distribution are addressed by the applicable NFPA standard. For other obstruction scenarios which are not addressed by NFPA, refer to the appropriate figures within this data sheet. If a sprinkler water distribution pattern is obstructed, the obstruction is to be considered the maximum distance of coverage for a given sprinkler and additional sprinklers beyond the obstruction will be necessary. Because of the varied nature of residential type construction, there will be some compartment designs that cannot be fully sprinklered in accordance with the recommendations of NFPA 13, 13D, or 13R. In the event of this condition, consult with the authority having jurisdiction.

Appendix material in NFPA 13D and 13R references the evaluation of certain small areas.

Small areas created by architectural features such as planter box windows, bay windows, and similar features can be evaluated as follows:

(a) Where no additional floor space area is created by the architectural feature, no additional sprinkler protection is required.

(b) Where additional floor space is created by an architectural feature, no additional sprinkler protection is required, provided all of the following conditions are met:

- The floor area does not exceed 18 square feet.
- The floor area is not greater than 2 feet in depth at the deepest point of the architectural feature to the plane of the primary wall where measured along the finished floor.
- The floor is not greater than 9 feet in length where measured along the plane of the primary wall.

Measurement from the deepest point of the architectural feature to the sprinkler should not exceed the maximum listed spacing of the sprinkler. The hydraulic design is not required to consider the area created by the architectural feature.

Figure 2 provides guidance for positioning of pendent and horizontal sidewall sprinklers with respect to obstructions along a wall, and in the case of pendent sprinklers the positioning of sprinklers on both sides of a continuous obstruction located at the ceiling. Consideration must be given to the size of the obstruction, as well as the allowable deflector-to ceiling distance.

Heat Sensitivity. Sensitivity to heat is critical for prompt operation of a residential sprinkler for a fire condition. The Technical Data Sheets referenced in Table A provide the allowable sprinkler deflector-to-ceiling distances.

Residential sprinklers are to be installed beneath smooth flat ceilings as defined by NFPA 13.

NOTICE

Special consideration, such as increasing the number of design sprinklers being hydraulically calculated, must be given to installations where continuous obstructions to heat flow are present (e.g.: beams, lintels, etc.).

Under a sloped ceiling, the residential sprinkler(s) located at the highest elevation must not be located more than 3 feet measured vertically down from the peak.

Rise, Inches	Run, Inches 1	2	3	4	5	6	7	8	9	10	11	12
12							60°	56°	53°	50°	46°	45°
11							58°	54°	51°	48°	45°	42°
10						59°	55°	51°	48°	45°	42°	40°
9						56°	52°	48°	45°	42°	39°	37°
8					58°	53°	49°	45°	42°	39°	36°	34°
7				60°	54°	49°	45°	41°	38°	35°	32°	30°
6				56°	50°	45°	41°	37°	34°	31°	29°	27°
5			59°	51°	45°	40°	36°	32°	29°	27°	24°	23°
4			63°	45°	39°	34°	30°	27°	24°	22°	20°	18°
3		56°	45°	37°	31°	27°	23°	21°	18°	17°	15°	14°
2		45°	34°	27°	22°	18°	16°	14°	13°	11°	10°	9°
1	45°	27°	18°	14°	11°	9°	8°	7°	6°	6°	5°	5°

TABLE B
RISE OVER RUN CONVERSION TO DEGREES OF SLOPE

Preventing Cold Solder. A minimum distance between residential sprinklers to prevent cold soldering (i.e., the wetting from an operated sprinkler onto an unoperated sprinkler that could prevent its potential to operate if needed) must be maintained.

Under horizontal ceilings, the minimum distance between residential sprinklers to prevent cold soldering is 8 feet.

Sloped ceilings, however, present more of a cause for concern for cold soldering, since the elevation of one sprinkler may be higher than another, resulting in a different distribution pattern than that of a horizontal ceiling condition.

Figure 1 - Spacing Rules Under Sloped Ceilings addresses the minimum acceptable distance under various sloped ceiling conditions that will take into account the prevention of cold soldering.

One solution to prevent cold soldering is to stagger the sprinklers so that the distance between two sprinklers is increased. In some case, baffles can be located midway between two closely located sprinklers to prevent cold soldering.

Proximity To A Heat Source. Sprinklers must be located so as to prevent an inadvertent operation due to exposure of normal heat sources. Location with respect to exposure of heat sources other than fire that may cause an inadvertent operation of a residential sprinkler. Refer to the applicable NFPA standard.

Installation

The Series LFII Residential Sprinklers must be installed in accordance with the applicable Technical Data Sheet referenced in Table A.

Care and Maintenance

The Series LFII Residential Sprinklers must be maintained and serviced in accordance with the applicable Technical Data Sheet referenced in Table A.

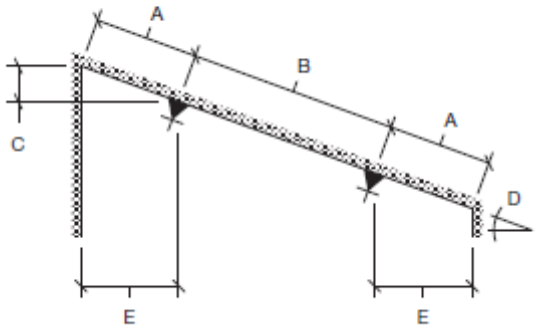
Sprinklers which are found to be leaking or exhibiting visible signs of corrosion must be replaced.

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable standards of the National Fire Protection Association (e.g., NFPA 25), in addition to the standards of any other authorities having jurisdiction. Contact the installing contractor or sprinkler manufacturer regarding any questions.

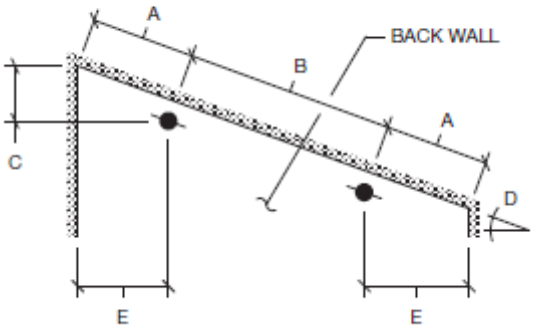
Automatic sprinkler systems should be inspected, tested, and maintained by a qualified Inspection Service in accordance with local requirements and/or national codes.

Limited Warranty

For warranty terms and conditions, visit www.tyco-fire.com.



PENDENT SPRINKLERS
ELEVATION



SIDEWALL SPRINKLERS
ELEVATION

A - MAXIMUM: ONE HALF THE MAXIMUM SPRINKLER SPACING (SEE TECHNICAL DATA SHEETS REFERENCED IN TABLE A) FOR THE COVERAGE AREA BEING HYDRAULICALLY CALCULATED

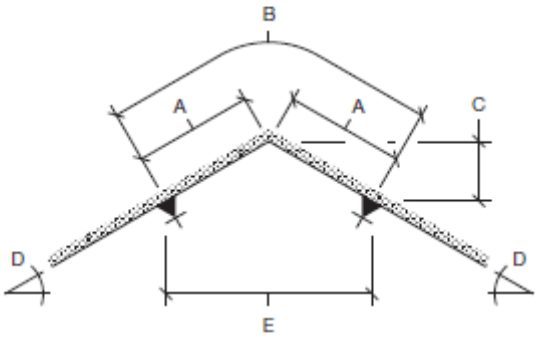
B - MAXIMUM: THE MAXIMUM SPRINKLER SPACING (SEE TECHNICAL DATA SHEETS REFERENCED IN TABLE A) FOR THE COVERAGE AREA BEING HYDRAULICALLY CALCULATED
MINIMUM: 8'-0"

C - MAXIMUM: 3'-0"

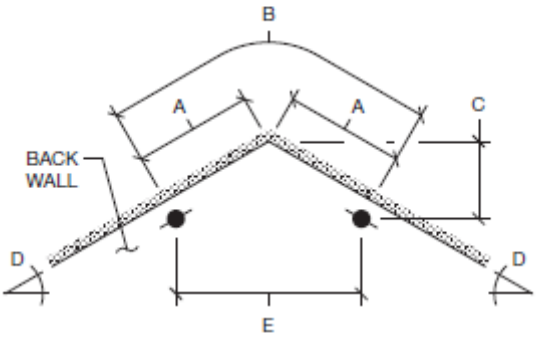
D - RANGE: 10° - 60° CEILING ANGLE.

E - MINIMUM: 4"

FIGURE 1 (PART 1 OF 6)
SPRINKLER SPACING UNDER HORIZONTAL CEILINGS
MULTIPLE SPRINKLERS ON SAME SLOPE AND DISTANCE OFF WALLS



PENDENT SPRINKLERS
ELEVATION



SIDEWALL SPRINKLERS
ELEVATION

A - MAXIMUM: ONE HALF THE MAXIMUM SPRINKLER SPACING (SEE TECHNICAL DATA SHEETS REFERENCED IN TABLE A) FOR THE COVERAGE AREA BEING HYDRAULICALLY CALCULATED

B - MAXIMUM: THE MAXIMUM SPRINKLER SPACING (SEE TECHNICAL DATA SHEETS REFERENCED IN TABLE A) FOR THE COVERAGE AREA BEING HYDRAULICALLY CALCULATED
MINIMUM: 8'-0"

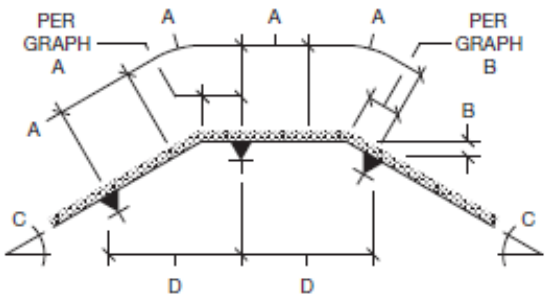
C - MAXIMUM: 3'-0"

D - RANGE: 10° - 60° CEILING ANGLE.

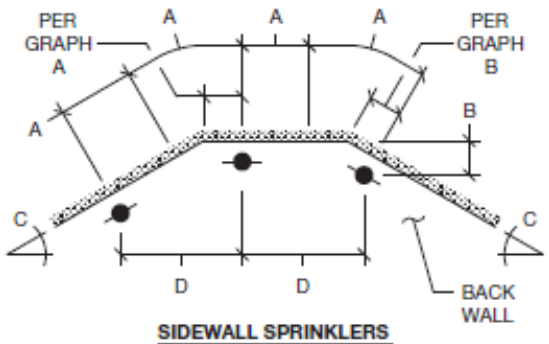
E - MINIMUM: 8'-0"

FIGURE 1 (PART 2 OF 6)
SPRINKLER SPACING UNDER SLOPED CEILINGS
SYMMETRIC SPRINKLER LOCATIONS ON OPPOSING SLOPES

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PENDENT SPRINKLERS
ELEVATION



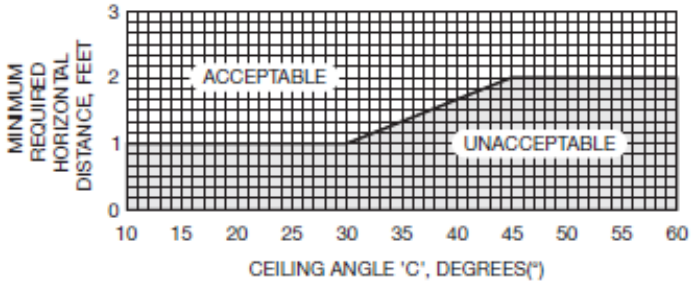
SIDEWALL SPRINKLERS
ELEVATION

A - MAXIMUM: ONE HALF THE MAXIMUM SPRINKLER SPACING (SEE TECHNICAL DATA SHEETS REFERENCED IN TABLE A) FOR THE COVERAGE AREA BEING HYDRAULICALLY CALCULATED.

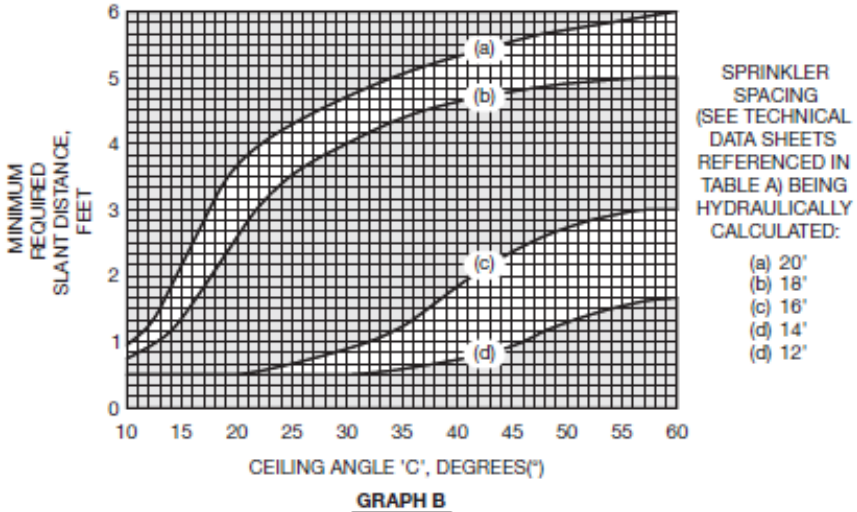
B - MAXIMUM: 3'-0" WHEN THERE ARE NO SPRINKLERS ON THE LEVEL CEILING

C - RANGE: 10° - 60° CEILING ANGLE.

D - MINIMUM: 8'-0"

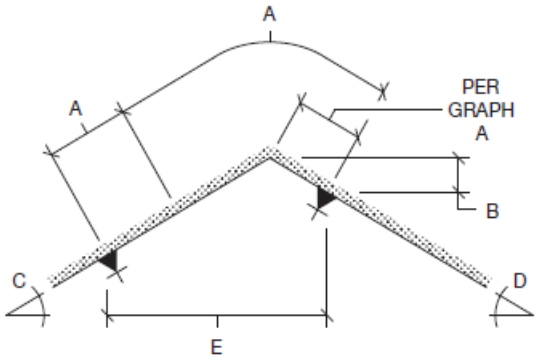


GRAPH A

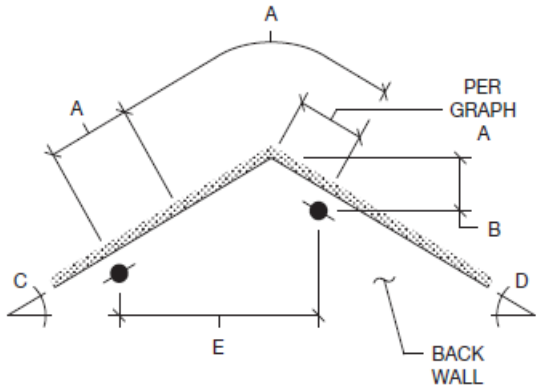


GRAPH B

FIGURE 1 (PART 3 OF 6)
SPRINKLER SPACING UNDER SLOPED CEILINGS
SPRINKLERS LOCATED ON INTERSECTING HORIZONTAL AND SLOPE CEILINGS



PENDENT SPRINKLERS
ELEVATION



SIDEWALL SPRINKLERS
ELEVATION

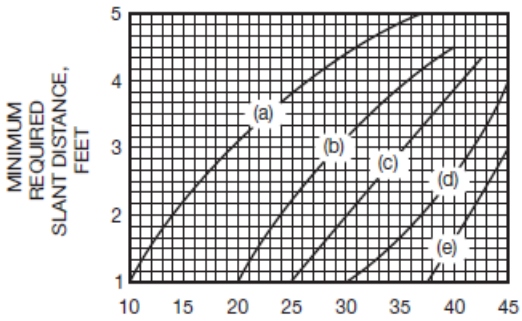
A - MAXIMUM: ONE HALF THE MAXIMUM SPRINKLER SPACING (SEE TECHNICAL DATA SHEETS REFERENCED IN TABLE A) FOR THE COVERAGE AREA BEING HYDRAULICALLY CALCULATED.

B - MAXIMUM: 3'-0"

C - RANGE: 10° - 45° CEILING ANGLE.

D - RANGE: 10° - 45° CEILING ANGLE.

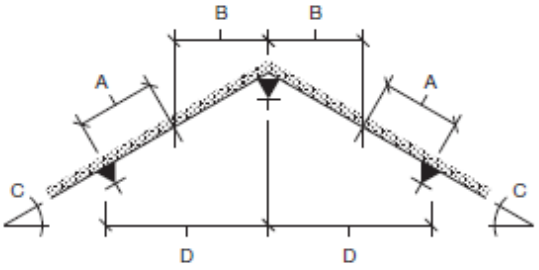
E - MINIMUM: 8'-0"



GRAPH A

FIGURE 1 (PART 4 OF 6)
SPRINKLER SPACING UNDER SLOPED CEILINGS
NON-SYMMETRIC SPRINKLER LOCATIONS ON OPPOSING SLOPES

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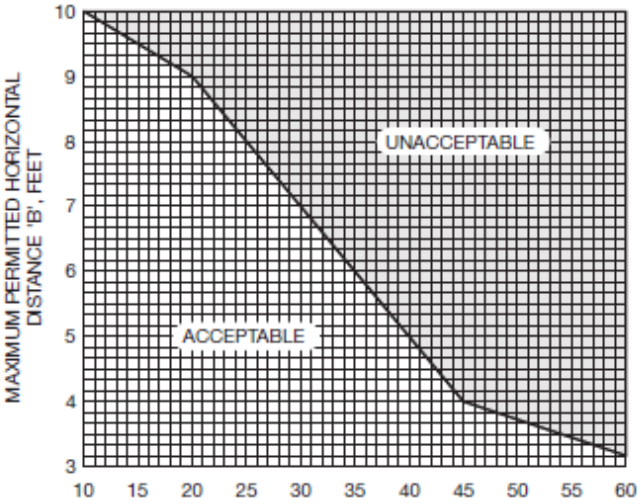
PENDENT SPRINKLERS
ELEVATION

A - MAXIMUM: ONE HALF THE MAXIMUM SPRINKLER SPACING (SEE TECHNICAL DATA SHEETS REFERENCED IN TABLE A) FOR THE COVERAGE AREA BEING HYDRAULICALLY CALCULATED

B - MAXIMUM: THE MAXIMUM SPRINKLER SPACING (SEE TECHNICAL DATA SHEETS REFERENCED IN TABLE A) FOR THE COVERAGE AREA BEING HYDRAULICALLY CALCULATED OR AS RESTRICTED BY GRAPH A

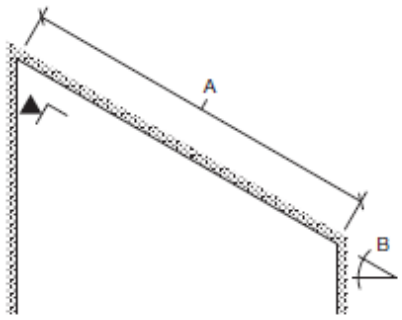
C - RANGE: 10° - 60° CEILING ANGLE.

D - MINIMUM: 8'-0"



GRAPH A

FIGURE 1 (PART 5 OF 6)
SPRINKLER SPACING UNDER SLOPED CEILINGS
PENDENT SPRINKLERS LOCATED AT PEAK



SIDEWALL SPRINKLERS
ELEVATION

A - MAXIMUM: UP TO THE MAXIMUM SPRINKLER COVERAGE AREA LENGTH (SEE TECHNICAL DATA SHEETS REFERENCED IN TABLE A) FOR THE COVERAGE AREA BEING HYDRAULICALLY CALCULATED.

B - RANGE: 10° - 45° CEILING ANGLE.

FIGURE 1 (PART 6 OF 6)
SPRINKLER SPACING UNDER SLOPED CEILINGS
SIDEWALL SPRINKLERS LOCATED AT PEAK

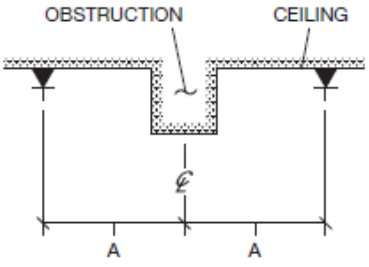


FIGURE 2 (PART 1 OF 2)
POSITION OF PENDENT SPRINKLERS ON OPPOSITE SIDES OF CONTINUOUS OBSTRUCTIONS AT THE CEILING

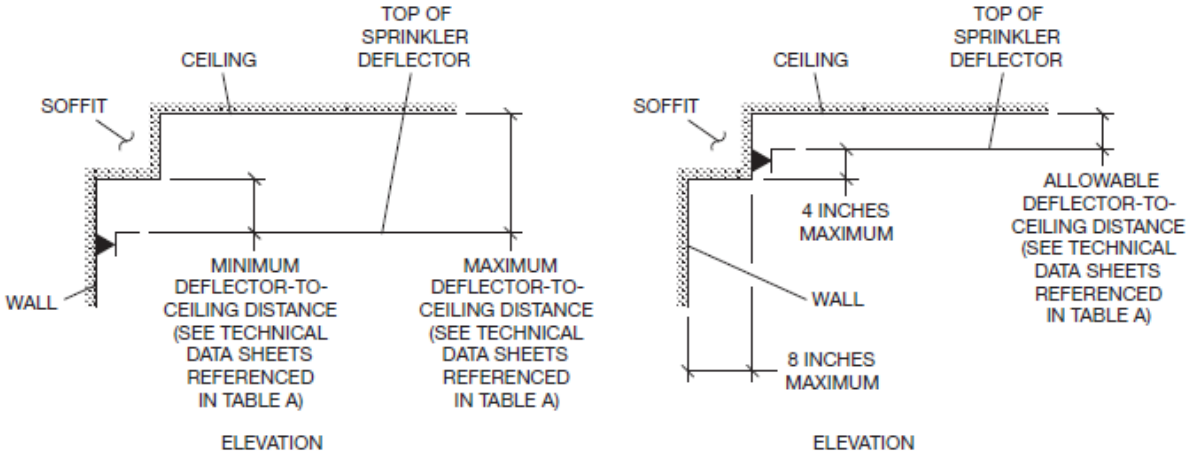


FIGURE 2 (PART 2 OF 2)
POSITION OF HORIZONTAL SIDEWALL SPRINKLERS WITH RESPECT TO OBSTRUCTIONS ALONG A WALL TO AVOID OBSTRUCTION TO WATER DISTRIBUTION

GLOBAL HEADQUARTERS | 1400 Pennbrook Parkway, Lansdale, PA 19446 | Telephone +1-215-362-0700

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UNIT 5: VERIFYING SPRINKLER COVERAGE AND HYDRAULIC DESIGN

TERMINAL OBJECTIVE

The students will be able to:

5.1 Evaluate the accuracy of computations on a set of plans with associated hydraulic calculations.

ENABLING OBJECTIVES

The students will be able to:

5.1 Verify that sprinkler spacing is in accordance with listing requirements, and that design assumptions have been included in hydraulic calculations.

5.2 Differentiate the flow characteristics of the four types of sprinkler pipe.

5.3 Verify that hydraulic calculations include a sufficient number of sprinklers (one- and two-head designs) and that all hydraulic reference points are identified on the plans.

5.4 Verify the calculation of a single sprinkler flow.

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FEMA

U.S. Fire Administration

UNIT 5: VERIFYING SPRINKLER COVERAGE AND HYDRAULIC DESIGN

Slide 5-1

TERMINAL OBJECTIVE

Evaluate the accuracy of computations on a set of plans with associated hydraulic calculations.

Slide 5-2

ENABLING OBJECTIVES

- Verify that sprinkler spacing is in accordance with listing requirements, and that design assumptions have been included in hydraulic calculations.
- Differentiate the flow characteristics of the four types of sprinkler pipe.

Slide 5-3

ENABLING OBJECTIVES (cont'd)

- Verify that hydraulic calculations include a sufficient number of sprinklers (one- and two-head designs) and that all hydraulic reference points are identified on the plans.
- Verify the calculation of a single sprinkler flow.

Slide 5-4

I. DESIGN CONSIDERATIONS

A. Automatic fire sprinkler systems may be designed using hydraulic calculations or by a prescriptive method.

HYDRAULIC DESIGN

- Uses calculations to verify that the water supply's pressure and volume are able to:
  - Provide enough flow at the correct pressure to each sprinkler to control a fire.
  - Develop enough flow at the correct pressure to all the sprinklers that are likely to open in a fire.
  - Minimize the overall size of the sprinkler distribution pipe (to reduce cost).

Slide 5-5

B. Hydraulic design uses calculations to verify that the water supply's pressure and volume are able to:

1. Provide enough flow at the correct pressure to each sprinkler to control a fire.

2. Develop enough flow at the correct pressure to all the sprinklers that are likely to open in a fire.

3. Minimize the overall size of the sprinkler distribution pipe (to reduce cost) without losing more pressure than the water supply can stand.

HYDRAULIC DESIGN (cont'd)

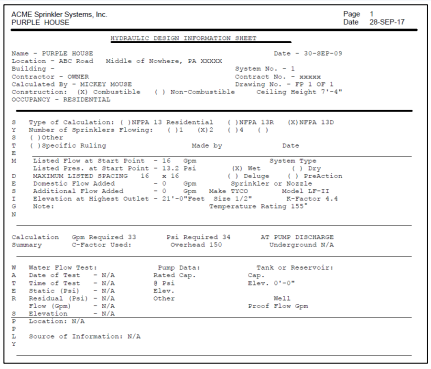
- Preferred design method in National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems*, 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, and 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*.

Slide 5-6

C. Hydraulic design is the preferred design option for systems designed in accordance with National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems*, 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, and 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*.

II. READING HYDRAULIC CALCULATIONS

READING HYDRAULIC CALCULATIONS



ACME Sprinkler Systems, Inc. Page 1
PURPLE HOUSE Date 28-SEP-17

HYDRAULIC DESIGN INFORMATION SHEET

Name - PURPLE HOUSE Date - 30-SEP-09
Location - ABC Road Middle of Nowhere, PA XXXXX
Building - System No. - 1
Contractor - OWNER Contract No. - XXXXX
Calculated By - MICKEY MOUSE Drawing No. - FP 1 OF 1
Construction: (X) Combustible ( ) Non-Combustible Ceiling Height 7'-4"
OCCUPANCY - RESIDENTIAL

S Type of Calculation: ( )NFPA 13 Residential ( )NFPA 13R (X)NFPA 13D
Y Number of Sprinklers Flowing: ( )1 (X)2 ( )4 ( )
S ( )Other
T ( )Specific Ruling Made by Date
E
M Listed Flow at Start Point - 16 Gpm System Type
Listed Pres. at Start Point - 13.2 Psi (X) Wet ( ) Dry
D MAXIMUM LISTED SPACING 16 x 16 ( ) Deluge ( ) Preaction
E Domestic Flow Added - 0 Gpm Sprinkler or Nozzle
P Additional Flow Added - 0 Gpm Make TYCO Model LF-II
I Elevation at Highest Outlet - 21'-0"Feet Size 1/2" K-Factor 6.4
G Note: Temperature Rating 155°
N

Calculation Gpm Required 33 Psi Required 34 AT PUMP DISCHARGE
Summary C-Factor Used: Overhead 150 Underground N/A

W Water Flow Test: Pump Data: Tank or Reservoir:
A Date of Test - N/A Rated Cap. Cap.
T Time of Test - N/A @ Psi Elev. 0'-0"
E Static (Psi) - N/A Elev.
R Residual (Psi) - N/A Other Well
Flow (Gpm) - N/A Proof Flow Gpm
S Elevation - N/A
P Location: N/A
P
L Source of Information: N/A
Y

Slide 5-7

A. Project cover sheet (ACME Sprinkler Systems, Inc.).

1. Includes designer's name and company contact information.

2. Not all designers provide this sheet since it is not a required part of a submittal.

B. Hydraulic design information sheet.

1. Includes all the assumptions the designer has incorporated into the project to meet the requirements of the appropriate design standard.

2. This is a required part of the submittal.

3. The top block describes the project details.

4. The second block outlines the foundational information for the system design:

    a. Sprinkler design standard selected.

    b. Number of design sprinklers flowing.

    c. Special rulings.

        - If the owner, contractor or code official has provided requirements different from the national design standards, they should be addressed here (e.g., more than the standard number of sprinklers flowing, densities greater than the standards require, etc.).

    d. Listed flow for the sprinkler(s) selected to be used as the design sprinklers.

    e. Listed pressure needed to provide the required flow.

    f. Maximum listed spacing for the selected sprinklers.

    g. Type of system to be used.

        - Wet.

        - Dry.

        - Preaction.

    h. Additional flow requirements (gallons per minute (gpm)) based on additional dwelling units of special rulings.

    i. Sprinkler make and model selected for the design, including K-factor.

    j. Elevation at the highest outlet (sprinkler).

        - Represents elevation difference between where water supply test was taken and highest sprinkler.

    k. Sprinkler temperature rating.

5. The next block includes the calculation summary, the total flow and pressure output resulting from the calculations. The sprinkler pipe C-factor is also included.

6. The final section provides water supply data:

    a. Date, time and test location.

    b. Static and residual pressures.

    c. Flow in gpm at test location.

    d. Elevation where test was performed.

    e. Pump data (if used).

    f. Tank, reservoir or well data (if used).

C. Water supply curve.

1. Represents a comparison of the sprinkler system performance in relation to the water supply test.

2. When a water supply test curve is shown, the sprinkler system demand (lower-left to upper-right diagonal line) must always occur below the water test curve.

3. The lower-left to upper-right diagonal line represents the sprinkler system demand.

    a. Starts at zero gpm flow at about 10 pounds per square inch (psi), which represents the elevation of the highest sprinkler.

    b. Ends at 32.1 gpm at 33.9 psi, which is the flow and pressure demand of the system with both design sprinklers operating.

D. Flow diagram.

Computerized representation of how the water flows from the source to the design sprinklers through the assigned nodes.

E. Fittings used summary.

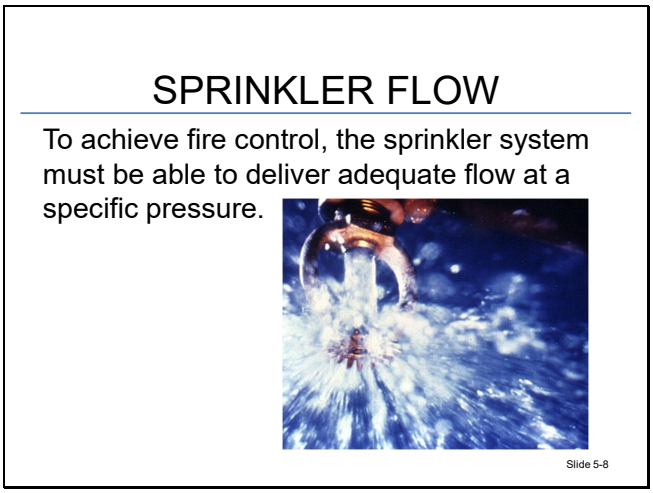
1. Provides information on the abbreviations used in the hydraulic printout for various fittings.

2. Includes the estimated friction loss at various flow rates for each fitting type and size.

F. Flow summary.

1. Provides a summary analysis of what is influencing water flow at various points in the system.

2. In this example, these points are referenced as **nodes;** they may also be called **hydraulic reference points.**



G. Final calculations/sprinkler flow.

1. In order to achieve fire control, the sprinkler system must be capable of delivering adequate flow at a specific pressure.

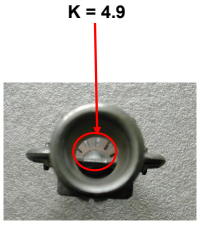
2. The hydraulic calculations will show the minimum flow and pressure requirement.

3. The values in the calculations should meet or exceed the pressure and volume requirements shown in the manufacturer's sprinkler tables for the selected configuration (smooth, flat ceiling, slope, spacing, etc.).

III. VERIFYING HYDRAULIC CALCULATIONS

SPRINKLER FLOW/PRESSURE

- Orifice size: K-factor.
- Constant coefficient of discharge.
  - Higher K-factor: lower friction loss/greater flow.
  - Lower K-factor: higher friction loss/lesser flow.



Slide 5-9

A. Sprinkler flow characteristics are identified by their K-factor, a mathematical constant coefficient of discharge.

1. The larger the K-value, the greater the flow.

2. Based on a minimum sprinkler operating pressure of 7 psi.

B. The plans examiner should verify the flow and pressure values shown in the hydraulic calculations that are submitted with the plans. To do this, the plans examiner must know the sprinkler K-factor, which is provided in the manufacturer's technical literature.

DISCHARGE CRITERIA GALLONS PER MINUTE

- For sprinklers that have listed discharge criteria, use the listed criteria.
- For sprinklers that do not have listed discharge criteria:
  - Minimum 18 gallons per minute (gpm) to any single sprinkler.
  - Minimum 13 gpm to all design sprinklers.

Slide 5-10

C. Discharge criteria.

1. For sprinklers that have specific discharge criteria (such as those described in the manufacturer's catalog literature), the system must provide at least the flow required for the multiple- and single-sprinkler operating criteria specified by the sprinkler listing. Use the manufacturer's tables in Unit 6: Prescriptive Design, Appendix: Residential Sprinkler Prescriptive Design to point out the minimum flow from one- and two-head sprinklers, then show where those values appear on the hydraulic calculations.

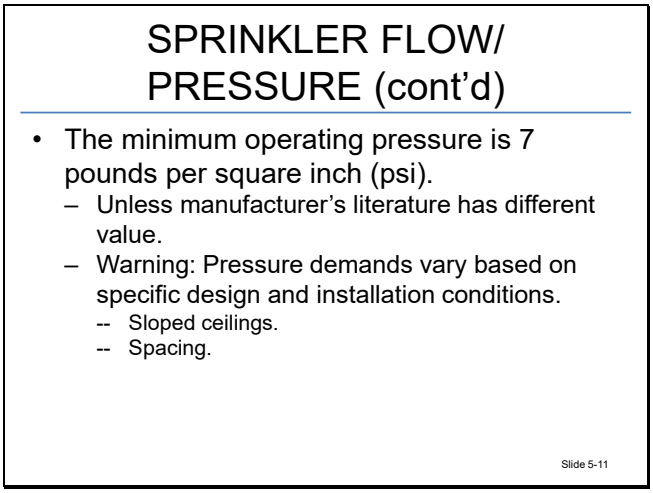
2. For sprinklers that do not have specific discharge criteria, the system must discharge at least 18 gpm to any single design sprinkler in the system.

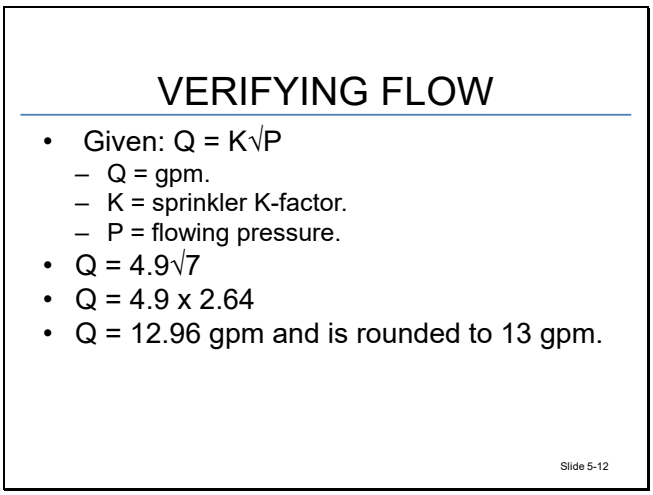
    a. This reference to sprinklers that do not have a specific discharge criteria is legacy language from early versions of NFPA 13D. There are no residential sprinklers in the market today that do not have a specific discharge criteria.

    b. However, there might be standard sprinklers installed in the non-dwelling portions of a structure that comprise the hydraulic remote area, so these values would be used in those conditions.

    c. The system must discharge at least 13 gpm per sprinkler simultaneously to all of the design sprinklers.

3. The submittal should include calculations for one- and two-head sprinkler operation.





D. To verify the flow of a single sprinkler, use the formula:

$Q = K\sqrt{p}$

Where:

Q = quantity in gpm.

K = sprinkler K-factor.

p = residual pressure in psi.

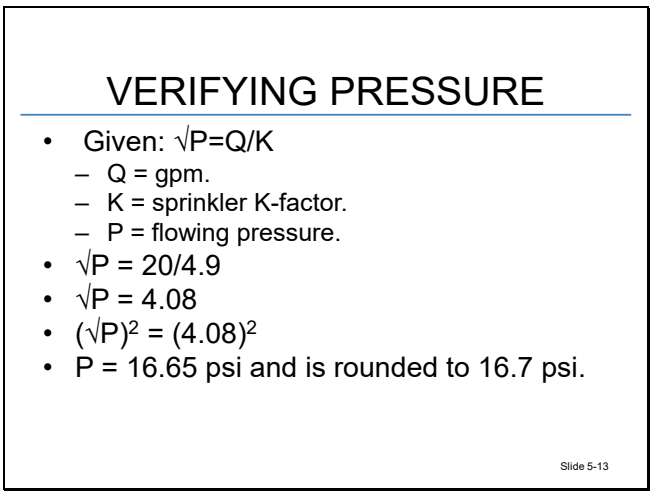
Example: Given a residential sprinkler with a K-factor of 4.9 at a flowing pressure of 7 psi, what is the flow in gpm?

1. $Q = 4.9\sqrt{7}$.

2. Q = 4.9 x 2.64.

3. Q = 12.96 gpm.

4. Round to 13 gpm.



E. Conversely, to verify the minimum required pressure to obtain a specific flow, use the following inverse formula:

$\sqrt{P}=Q/K$

Where:

Q = quantity in gpm.

K = sprinkler K-factor.

p = residual pressure in psi.

Example: Given a residential sprinkler with a K-factor of 4.9, what pressure is required to obtain a flow of 20 gpm?

1. $20/4.9 = \sqrt{p}$.

2. $4.08 = \sqrt{p}$.

3. $(4.08)2 = (\sqrt{p})2$.

4. $16.65 = p$.

5. Round to 16.7 psi.

MANUFACTURER'S LISTING INFORMATION

Maximum Coverage Area [a] Ft. x Ft. (m x m)	Maximum Spacing Ft. (m)	Minimum Flow [b] and Residual Pressure For Horizontal Ceiling (Max. 2 Inch Rise for 12 Inch Run)	Minimum Flow [b] and Residual Pressure For Sloped Ceiling (Greater Than 2 Inch Rise Up To Max. 4 Inch Rise for 12 Inch Run)		Minimum Flow [b] and Residual Pressure For Sloped Ceiling (Greater Than 4 Inch Rise Up To Max. 8 Inch Rise for 12 Inch Run)	
		155°F/68°C or 175°F/79°C	155°F/68°C	175°F/79°C	155°F/68°C	175°F/79°C
12 x 12 (3,7 x 3,7)	12 (3,7)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
14 x 14 (4,3 x 4,3)	14 (4,3)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
16 x 16 (4,9 x 4,9)	16 (4,9)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
18 x 18 (5,5 x 5,5)	18 (5,5)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
20 x 20 (6,1 x 6,1)	20 (6,1)	20 GPM (75,7 LPM) 16.7 psi (1,15 bar)	20 GPM (75,7 LPM) 16.7 psi (1,15 bar)	20 GPM (75,7 LPM) 16.7 psi (1,15 bar)	21 GPM (79,5 LPM) 18.4 psi (1,27 bar)	22 GPM (83,3 LPM) 20.2 psi (1,39 bar)

(a) For coverage area dimensions less than or between those indicated, it is necessary to use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.

(b) Requirement is based on minimum flow in GPM (LPM) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design Criteria Section for details.

TABLE A
NFPA 13D AND NFPA 13R WET PIPE HYDRAULIC DESIGN CRITERIA FOR THE SERIES LFII (TY2234) RESIDENTIAL PENDENT AND RECESSED PENDENT SPRINKLERS

Slide 5-14

F. Design density option.

1. In NFPA 13 (13D or 13R), designers may use the specified number of design sprinklers or may choose to design a system based on a design density of 0.05 gpm per square foot.

2. The design density method is a sprinkler design scheme more often used in commercial-type or large, open area structures. Depending upon the fire load and other factors, the sprinkler designer must show that the system is capable of delivering a minimum specific amount of water over a specific-sized area called the hydraulic design area or remote area.

3. For example, if the standard specifies the sprinkler system must deliver a density of 0.05 gpm per square foot, that means that all of the sprinklers in the hydraulic design area or remote area must be capable of providing 0.05 gpm over every square foot of the design area. If the design area is 800 square feet, the sprinkler system must be capable of flowing at least 40 gpm.

   $0.05 \text{ gpm/ft}^2 \times 800 \text{ ft}^2 = 40 \text{ gpm}$

4. The actual flow value will be more than 80 gpm, because the system will need to provide more water to fill the pipes and flow all the sprinklers at the design rate.

5. The minimum design area for commercial-type or large, open area structures is provided in NFPA 13 or as required by the code official.

6. In a residential application, imagine a great room or large recreation room that measures 20 feet by 28 feet (560 square feet). (This is an arbitrary number selected for an example.)

7. At a required density of 0.05 gpm per square foot, the required flow for this room would be:

   $0.1 \text{ gpm/ft}^2 \times 560 \text{ ft}^2 = 28 \text{ gpm}$

8. This outcome value is very similar to the design sprinkler method that has been used in the standards.

SPRINKLER SPACING

- Area of sprinkler coverage.
  - Affects volume and pressure requirements.
- Various conditions.
  - Ceiling slope, spacing, available water supply.

Slide 5-15

G. One of the key elements to adequate sprinkler performance is the amount of area a single sprinkler will cover. The goal is to ensure that all portions of the room are within the spray pattern of one or more sprinklers.

Based on the coverage area and number of sprinklers, the designer must ensure that there is adequate volume at adequate pressure to operate the system, which is the basis for the hydraulic design.

SPRINKLER AREA LIMITS/ SPACING

$S \times L = (A_S)$

Where:

- S: larger of **twice the distance to the wall/ obstruction** or **distance to next sprinkler on branch line.**
- L: larger of **twice the distance to the wall/ obstruction** or **spacing between branch lines.**

Slide 5-16

H. Sprinkler area limits and spacing. Design coverage area is based on the formula:

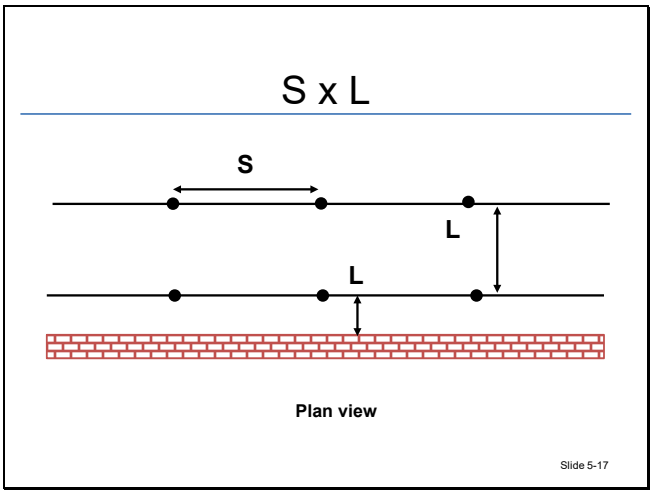
$S \times L = A_s$

Where:

S = larger of **twice the distance to the wall/obstruction** or **the distance to next sprinkler on branch line.**

L = larger of **twice the distance to the wall/obstruction** or **the spacing between branch lines.**

A_s = area of coverage per sprinkler.



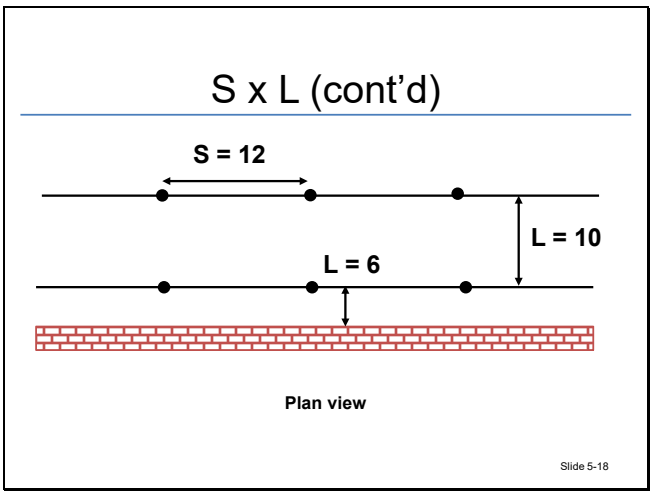
I. Slide 5-17 represents where the dimensions S and L are taken.

1. S is the spacing between sprinklers along a branch line.

2. L will be either the:

   a. Space between the branch lines.

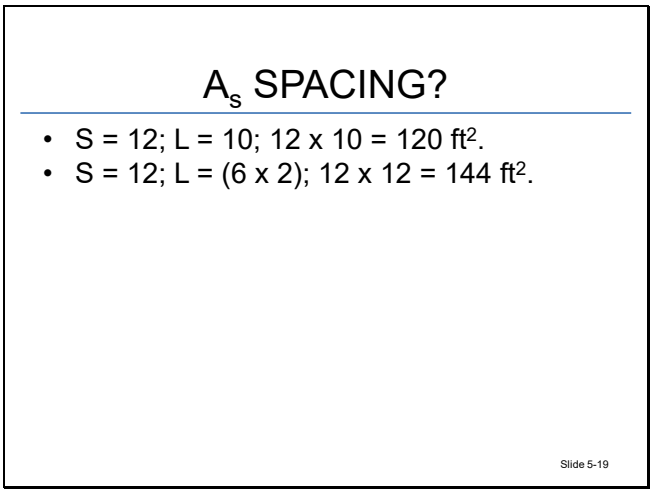
   b. Twice the distance between the lower branch line and the wall (obstruction).



J. Slide 5-18 adds values to the formula:

1. S = 12 feet.

2. L = 10 feet, or, twice 6 feet (12 feet).



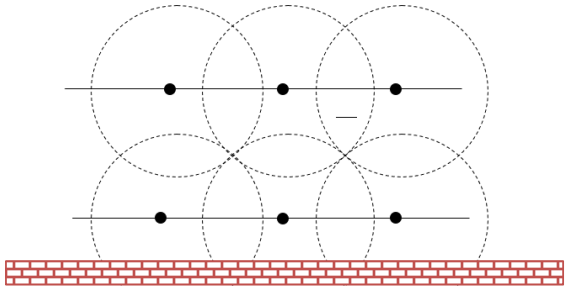
K. Slide 5-19 provides two answers:

1. S = 12; L = 10; 12 x 10 = 120 ft^2.

2. S = 12; L = (6 x 2); 12 x 12 = 144 ft^2.

The correct answer is that the sprinkler **design** coverage area is the **greater** of the two values, i.e., 144 square feet.

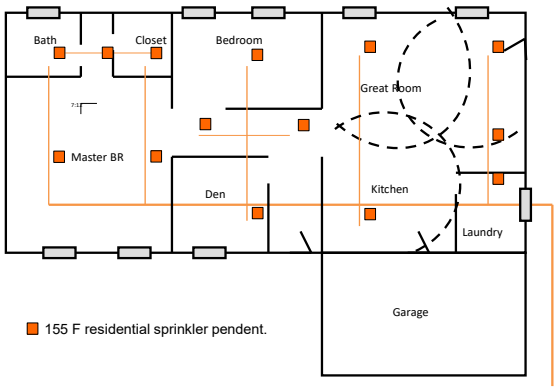
DISCHARGE OVERLAP



Plan view

Slide 5-20

L. Slide 5-20 represents the typical sprinkler round spray discharge pattern. The spacing results from the equation S x L = A_s assuring that the sprinklers will provide discharge overlap.



Slide 5-21

MANUFACTURER'S LISTING INFORMATION (cont'd)

Maximum Coverage Area [a] Ft. x Ft. (m x m)	Maximum Spacing Ft. (m)	Minimum Flow [b] and Residual Pressure For Horizontal Ceiling (Max. 2 Inch Rise for 12 Inch Run)	Minimum Flow [b] and Residual Pressure For Sloped Ceiling (Greater Than 2 Inch Rise Up To Max. 4 Inch Rise for 12 Inch Run)		Minimum Flow [b] and Residual Pressure For Sloped Ceiling (Greater Than 4 Inch Rise Up To Max. 8 Inch Rise for 12 Inch Run)	
		155°F/68°C or 175°F/79°C	155°F/68°C	175°F/79°C	155°F/68°C	175°F/79°C
12 x 12 (3,7 x 3,7)	12 (3,7)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
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18 x 18 (5,5 x 5,5)	18 (5,5)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
20 x 20 (6,1 x 6,1)	20 (6,1)	20 GPM (75,7 LPM) 16.7 psi (1,15 bar)	20 GPM (75,7 LPM) 16.7 psi (1,15 bar)	20 GPM (75,7 LPM) 16.7 psi (1,15 bar)	21 GPM (79,5 LPM) 18.4 psi (1,27 bar)	22 GPM (83,3 LPM) 20.2 psi (1,39 bar)

(a) For coverage area dimensions less than or between those indicated, it is necessary to use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.

(b) Requirement is based on minimum flow in GPM (LPM) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design Criteria Section for details.

TABLE A
NFPA 13D AND NFPA 13R WET PIPE HYDRAULIC DESIGN CRITERIA FOR THE SERIES LFII (TY2234) RESIDENTIAL PENDENT AND RECESSED PENDENT SPRINKLERS

Slide 5-22

M. Manufacturer's listing information and catalog sheets provide the maximum area of coverage per sprinkler for various conditions.

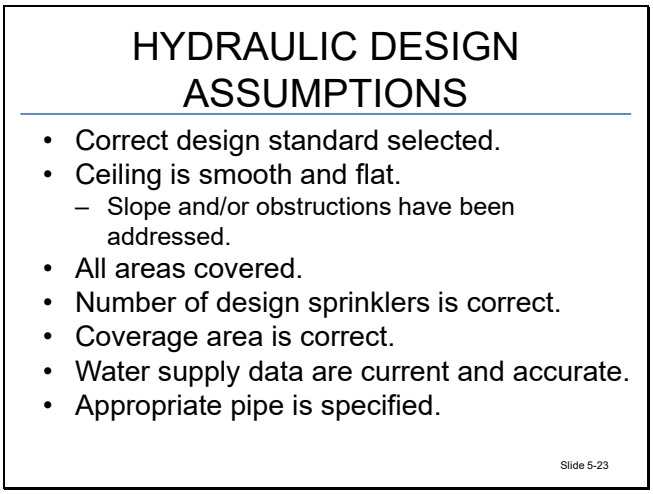
These conditions include ceiling configuration, slope, available water pressure and available water volume.

N. The maximum coverage area varies depending upon water pressure and volume delivered to the sprinklers.

1. Generally, given the same sprinkler, increased pressure and volume are needed to increase coverage areas.

2. Residential sprinklers should not be installed within 8 feet of one another (unless listed for lesser spacing) to prevent cold soldering.

   Cold soldering describes the condition where the sprinkler discharge from one sprinkler hits the operating element of another, thereby cooling it and preventing it from opening.



O. Design assumptions.

The sprinkler system designer will base their design on a variety of assumptions regarding the system. These assumptions provide the design framework and should be verified by the plans examiner. These design assumptions include:

1. The correct NFPA design standard has been selected for the occupancy.

2. The ceiling is smooth and flat, or obstructions that may affect water distribution patterns or sprinkler spacing have been identified.

3. All areas requiring sprinkler protection have been provided with coverage.

4. The number of design sprinklers is correct.

   Design sprinklers are the one, two (NFPA 13D) or four (NFPA 13R) sprinklers that the system designer has selected as hydraulically most challenging; that is, they are likely the farthest from the water source and most difficult to serve at the required pressure and volume due to elevation, distance and friction loss in the pipe.

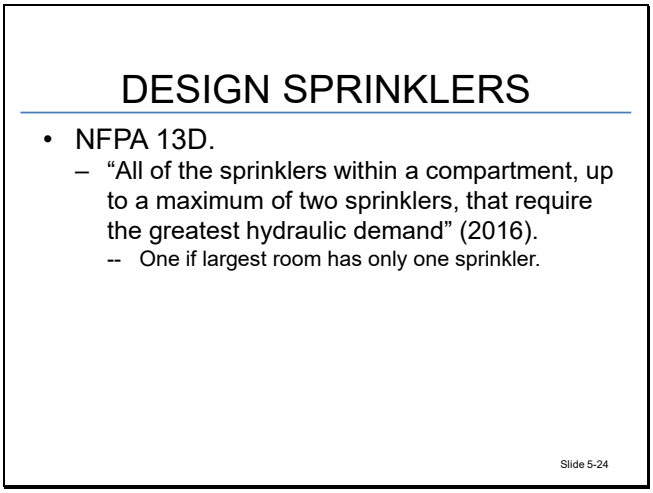
5. The area of coverage per sprinkler is specified and accurate. It complies with NFPA 13D and/or the manufacturer's specifications.

6. The water supply data have been provided.

   a. They are current.

   b. They were taken and calculated correctly.

7. The appropriate type of pipe(s) is being used for water distribution. The type of pipe influences the water flow characteristics due to the interior roughness and carrying capacity.



P. Number of design sprinklers.

1. For NFPA 13D designs, the system must provide adequate flow to one or two sprinklers in the largest compartment (room).

   a. A room may have more sprinklers in it (such as a great room or bonus room), but the designer must only prove the system is capable of supplying two sprinklers simultaneously.

   b. If the largest room has only one sprinkler, the calculations must meet its required flow rate and pressure.

DESIGN SPRINKLERS (cont'd)

- NFPA 13R.
  - "All of the sprinklers within a compartment, up to a maximum of four sprinklers, that require the greatest hydraulic demand" (2016).

Slide 5-25

2. For NFPA 13R designs, the system must provide adequate flow to four sprinklers in the largest compartment (room).

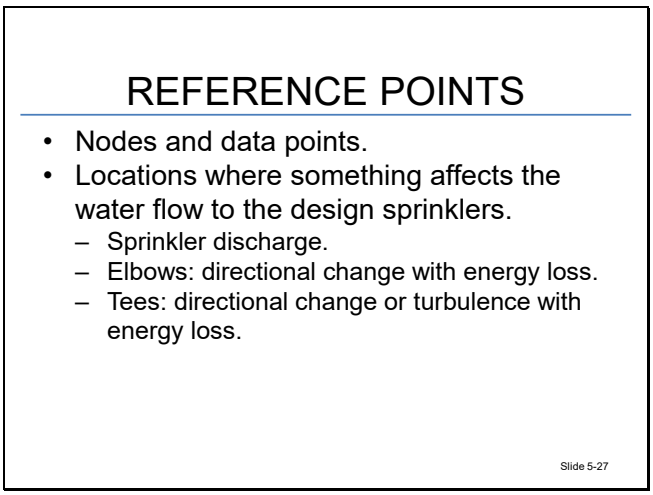
DESIGN SPRINKLERS (cont'd)

- NFPA 13.
  - "The area that includes the four adjacent sprinklers that produce the greatest hydraulic demand."
    - -- "For buildings having unsprinklered combustible concealed spaces … the minimum design area of sprinkler operation for that portion of the building shall be eight sprinklers" (2016).

Slide 5-26

3. For NFPA 13 designs, it is "the area that includes the four adjacent sprinklers that produce the greatest hydraulic demand."

   "For buildings having unsprinklered combustible concealed spaces … the minimum design area of sprinkler operation for that portion of the building shall be eight sprinklers" (2016).



Q. Reference points or nodes.

1. Sprinkler systems designed hydraulically will be identified on the plans by hydraulic reference points or nodes and will be accompanied by one or more sets of hydraulic calculations.

   In its simplest form, hydraulic demand equals pressure loss. The hydraulic calculations are used to prove there is adequate water pressure to overcome the pressure loss and still provide adequate pressure and flow to the design sprinklers so that they will deliver the minimum required pressure and flow when they are operating simultaneously.

2. Reference points or nodes are identified along the critical path of the water flow from its source to the design sprinklers.

3. Reference points or nodes represent those locations where something affects the water flow to the design sprinklers.

   a. Sprinkler discharge.

   b. Elbows: directional change with energy loss.

   c. Tees: directional change or turbulence with energy loss.

REFERENCE POINTS (cont'd)

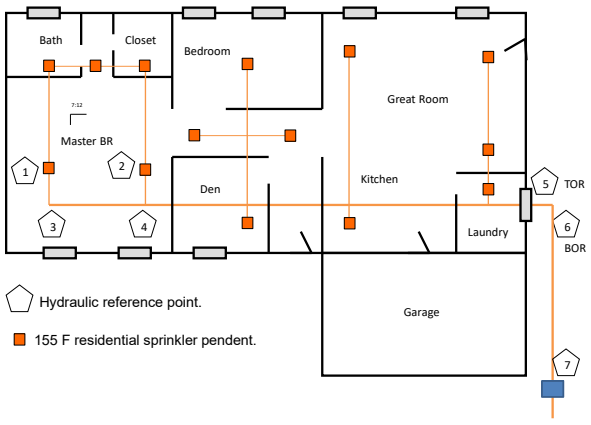
- Fittings: friction-loss influence.
- Valves: friction-loss influence.
- Risers/Drops: influence pressure changes due to elevation.

Slide 5-28

d. Fittings and valves: friction loss influence.

e. Risers/Drops: influence pressure changes due to elevation.

f. Top of riser/bottom of riser: changes of direction and elevation, as well as connecting to water meters, backflow prevention devices, pumps, tanks, etc.



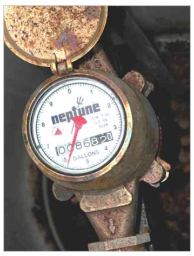
Slide 5-29

4. In the illustration on Slide 5-29, the nodes in the bedroom are selected because they occur in the largest room that is hydraulically most remote from the source. Therefore, two design sprinklers are required to satisfy NFPA 13D.

5. Even though there are other sprinklers (bathroom and closet) that may be physically more remote from the source, the total demand (flow and pressure) is greater in the bedroom because of the potential for two sprinklers to be operating simultaneously.

WATER METERS/BACKFLOW

- Not required as part of sprinkler design standards.
  - Check with local water purveyor.
- Can have serious negative effect on water flow due to friction loss.
  - As flow increases, so does friction loss.
  - Refer to meter manufacturer for loss values.



Slide 5-30

R. Water meters and backflow devices can have significant impacts reducing the water pressure to a sprinkler system.

1. Water meters and backflow prevention devices are not required as part of sprinkler design standards.

   Check with local water purveyor.

2. Can have a serious negative effect on water flow due to friction loss.

   a. As flow increases, so does friction loss.

   b. Refer to meter manufacturer for loss values.

WATER METER INFLUENCE (SAMPLE)

Pressure Loss (psi) in Various Meter Sizes

Meter size (in.)	18 gpm	23 gpm	26 gpm	31 gpm	39 gpm	52 gpm
5/8	9	14	18	26	*	*
3/4	4	8	9	13	*	*
1	2	3	3	4	6	10
1	**	1	2	2	4	7
2	**	**	**	1	2	3

* Above maximum flow of commonly available meters.
** Less than 1 psi.

Slide 5-31

S. Use Slide 5-31 to describe the pressure reducing effect of typical water meters.

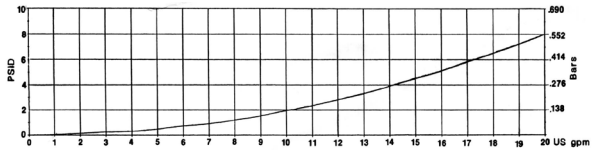
1. The left column represents typical water meter sizes.

2. The top row represents sample flows in gpm.

3. The corresponding tabular values are typical losses in psi through these typical meters.

WATER METER INFLUENCE (SAMPLE) (cont'd)

Neptune Model T-10 5/8-inch domestic meter loss



Slide 5-32

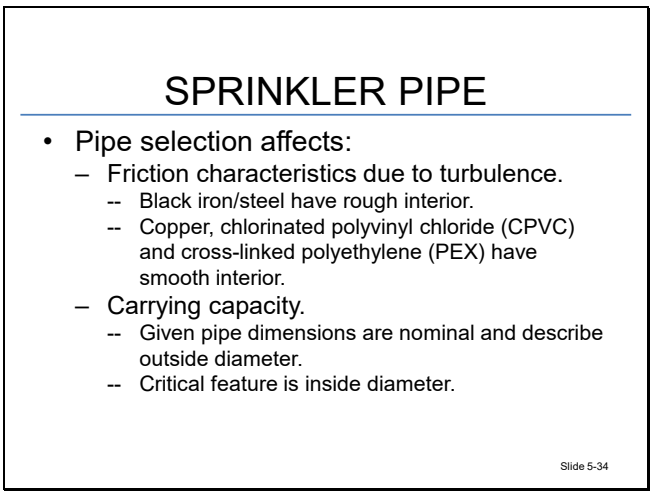
T. Slide 5-32 represents the loss through a sample Neptune Model T-10 5/8-inch domestic water meter.

KNOWLEDGE CHECK

Where should nodes be located? (Select all that apply.)

A. Valves.
B. Elbows.
C. Risers/Drops.
D. Fittings.

Slide 5-33



U. Pipe selection effects on water flow.

1. The type of pipe selected to supply the sprinklers affects the hydraulic performance.

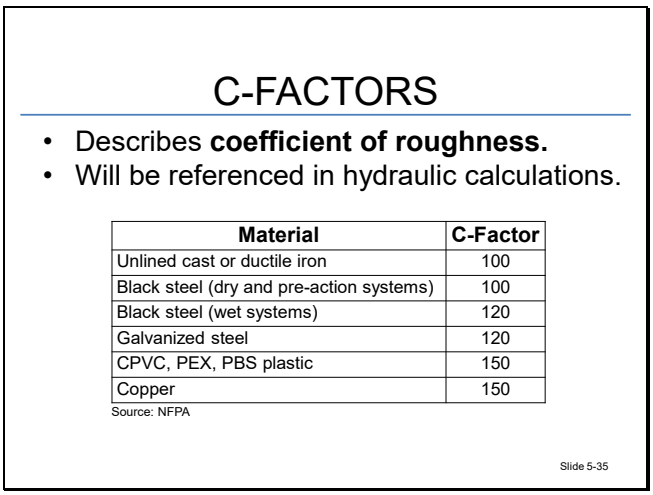
   a. Friction characteristics due to turbulence.

   b. Carrying capacity.

2. The pipe's interior smoothness affects the flow. As water moves through the pipe, the design goal is to create a smooth, laminar flow, thereby reducing the influence of friction.

   a. Some pipe materials, particularly black iron, steel or galvanized steel, have relatively rough interiors that contribute to turbulence and increase friction. Increased friction translates to pressure loss that must be overcome.

   b. Chlorinated polyvinyl chloride (CPVC), cross-linked polyethylene (PEX) and copper have smoother interior surfaces and allow more laminar flow.



c. The interior smoothness characteristics are identified as the pipe's **C-factor,** which is a coefficient of roughness of the pipe's interior and varies with the material that is used.

- C-factor of various materials used in sprinkler systems.

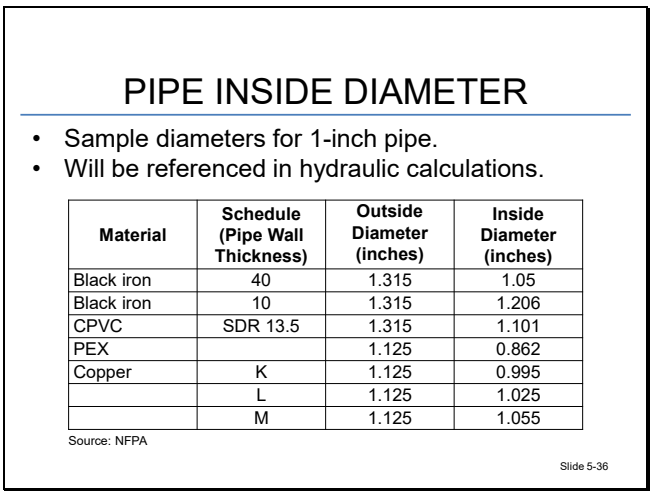
Material	C-Factor
Unlined cast or ductile iron	100
Black steel (dry and pre-action systems)	100
Black steel (wet systems)	120
Galvanized steel	120
CPVC, PEX, PBS plastic	150
Copper	150

Source: NFPA

- The higher the C-factor number, the better the flow characteristics.

3. Plans review must confirm that the C-factors have been correctly identified in the hydraulic calculations back to the point of connection (where the supply is connected to the system). The calculation may have to be shown all the way to the street connection.

   Use pipe manufacturer's C-factor values if their documentation proves another value is appropriate.



4. Pipe dimensions that are shown on the plans are generally the **outside diameter** and do not accurately reflect the pipe's **inside diameter** water-carrying capacity.

   a. For the purposes of hydraulic calculations, it is the inside diameter of the pipe that is crucial.

   b. Sample inside diameters for typical 1-inch (nominal) pipe:

Material	Schedule (pipe wall thickness)	Outside Diameter (inches)	Inside Diameter (inches)
Black iron	40	1.315	1.05
Black iron	10	1.315	1.206
CPVC	SDR* 13.5	1.315	1.101
PEX		1.125	0.862
Copper	K	1.125	0.995
	L	1.125	1.025
	M	1.125	1.055

Source: NFPA 13. *Standard Dimension Ratio (SDR).

- The CPVC pipe has an outside diameter like iron pipe, but with a different inside diameter.

- Many polyethylene (PE) pipe manufacturers use the SDR method of rating pressure piping. The SDR is the ratio of pipe diameter to wall thickness, and the SDR can be expressed as:

  SDR = D/s (1)

Where:

-- D = pipe outside diameter (inches).

-- S = pipe wall thickness (inches).

- An SDR of 15 means that the outside diameter of the pipe is 15 times the thickness of the wall.

- A high SDR ratio means the pipe wall is thin compared to the pipe diameter. A low SDR ratio means the pipe wall is thick compared to the pipe diameter. As a result, a high SDR pipe has a low-pressure rating, and a low SDR pipe has a high-pressure rating.

c. Use pipe manufacturer's inside diameter values if their documentation proves another value is appropriate.

- The volume of a length of pipe can be computed by the formula:

$V = (\pi r^2 h)/231$

Where:

-- V = volume in gallons.

-- π = pi (constant 3.1415).

-- r = inside radius of the pipe.

-- h = pipe height (length).

-- 231 = number of cubic inches in a gallon.

- **Example 1:** What is the carrying capacity of 1 foot of Schedule 40 black iron?

-- $V= (\pi r2h)/231$

-- $V = (3.1415 \times 0.525^2 \times 1)/231$

(Note that the radius is one-half the diameter.)

-- V = 0.00374

- **Example 2:** What is the carrying capacity of 1 foot of Schedule 40 CPVC?

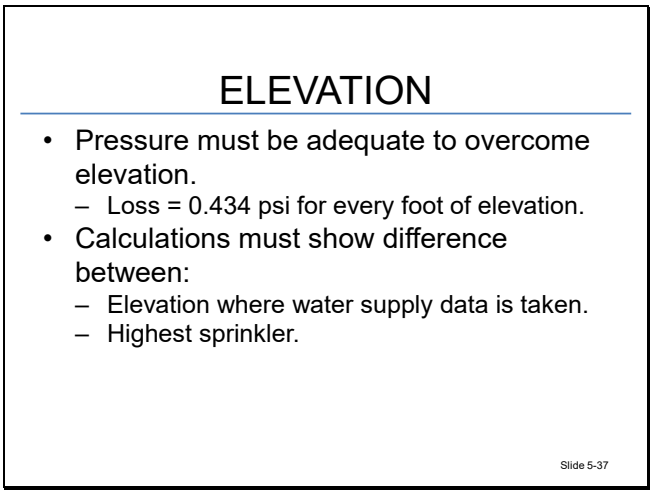
  -- $V = (\pi r^2 h)/231$

  -- $V = (3.1415 \times 0.5505^2 \times 1)/231$

  (Note that the radius is one-half the diameter.)

  -- $V = 0.00412$

- While the differences may appear insignificant in one foot of pipe, over the entire length of the sprinkler system, the accumulated effect may alter the accuracy of the calculations.



V. Elevation influence.

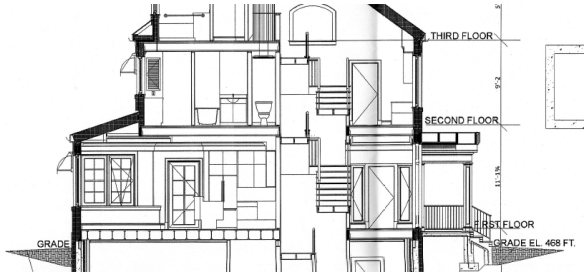
1. The pressure-loss effects of elevation must be taken into account in the calculations.

   a. Pressure loss per foot of elevation is 0.434 psi. (Some texts use 0.433 psi per foot.)

   b. 1 psi = 2.31 feet of head.

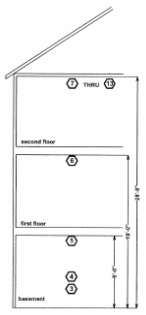
2. Calculations must reflect an elevation difference between the point where the water supply enters the dwelling (usually identified as the source) and the highest sprinkler.

ELEVATION EXAMPLE 1



Slide 5-38

ELEVATION EXAMPLE 2

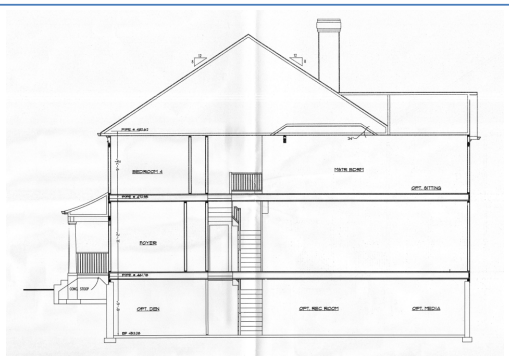


Slide 5-39

a. If the water supply test data represent a different elevation for the source, this difference must be addressed in the calculations.

b. For example, if the water supply data were taken at an elevation of 658 feet above sea level (ASL), and the point where the water supply enters the dwelling is 680 feet ASL, the lower elevation should be used for determining the difference between the highest point and the source since that is where the test data was collected.

ELEVATION EXAMPLE 3



Slide 5-40

3. Elevation must be shown on plans or on a sectional drawing that can be scaled.

KNOWLEDGE CHECK

Which of the following pipe materials has the roughest interior?

A. Copper.
B. PEX.
C. Black iron.
D. Galvanized steel.
E. CPVC.

Slide 5-41

QUICK COMPARISON

	NFPA 13	NFPA 13R	NFPA 13D/IRC P2940
Scope	All occupancies	Group R to four stories in height	One- and two-family and townhouses
Coverage	Entire building	Occupied spaces	Occupied spaces
Sprinkler design	Control mode, pipe schedule, hydraulic design, minimum 0.1 gpm/square foot	Life-safety control mode, four-head design, or 0.05 gpm/square foot	Life-safety control mode, two-head design, or 0.05 gpm/square foot
Sprinklers	All approved types, residential in dwelling unit and adjacent corridor	Residential in dwelling unit and adjacent corridor, other approved types elsewhere	Residential in dwelling unit, other approved types elsewhere
Water demand	System, plus 100 to 500 gpm	± 52 gpm	± 26 gpm
Duration	30 to 120 minutes	30 minutes	7 to 10 minutes
Fire Department Connection (FDC)	Yes, with some exceptions	Yes, if > 2,000 square feet or > one story	Optional

Slide 5-42

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ACTIVITY 5.1

Verifying Hydraulic Design Assumptions

Purpose

Demonstrate the data needed and steps taken to verify the completeness of a residential sprinkler hydraulic design.

Directions

1. You will work in small groups to answer the questions in this activity.

2. When completed, you should be prepared to discuss your answers in class.

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ACTIVITY 5.1 (cont'd)

Worksheet

Questions

1. A three-story residential sprinkler plan shows an elevation difference of 43 feet from where the pipe enters the dwelling to the highest sprinkler. How much pressure loss should be expected in this elevation difference?

2. What is the minimum number of design sprinklers that can be used in an NFPA 13D design?

3. What is the C-factor for new copper pipe?

4. A residential sprinkler has a listed K-factor of 2.8. The operating pressure is shown as 23.2 psi. What is the expected flow from this sprinkler?

5. A listed residential sprinkler has a coverage area of 16 feet by 16 feet.

   The plans reviewer discovers that the branch lines are spaced 12 feet apart, and the sprinklers on each branch line are 14 feet apart. Is this sprinkler suitable for this design?

6. What is the minimum number of design sprinklers that can be used in an NFPA 13R design?

7. Which of the following does **not** need to be identified as a hydraulic node or reference point on the calculation sheets?

   a. Pipe elbow.
   b. Pipe tee.
   c. Water meter.
   d. Riser pressure gauge.

8. Which of the following is true about sprinkler K-factors?

   a. A higher K-factor value means lower friction loss and greater flow.
   b. A lower K-factor value means lower friction loss and lesser flow.
   c. A higher K-factor value means higher friction loss and greater flow.
   d. A lower K-factor value means lower friction loss and restricted flow.

9. According to NFPA 13D, for sprinklers that do not have a listed discharge criterion, the minimum flow to a single sprinkler must be _____ gpm.

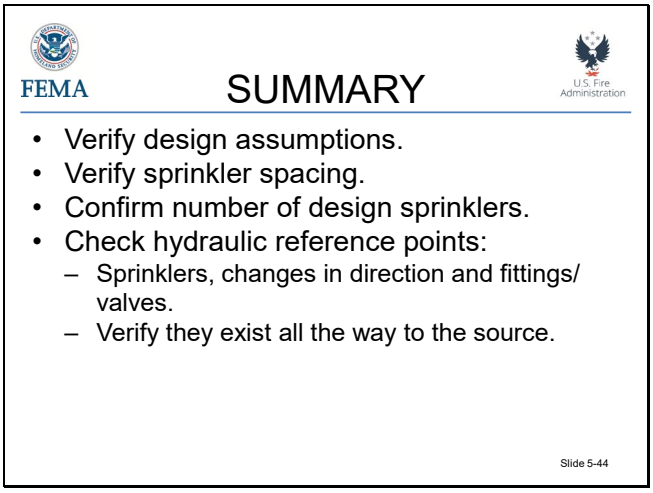
   a. 12.48
   b. 13
   c. 14.7
   d. 18

10. According to NFPA 13, 13R and 13D, unless listed otherwise, the minimum operating pressure for any sprinkler is _____ psi.

    a. 5
    b. 7
    c. 9
    d. 13

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IV. SUMMARY


FEMA
SUMMARY
U.S. Fire Administration
• Verify design assumptions.
• Verify sprinkler spacing.
• Confirm number of design sprinklers.
• Check hydraulic reference points:
– Sprinklers, changes in direction and fittings/ valves.
– Verify they exist all the way to the source.
Slide 5-44

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REFERENCES

NFPA. (2016). *Standard for the installation of sprinkler systems*. (Standard No. 13). Retrieved from www.nfpa.org

NFPA. (2016). *Standard for the installation of sprinkler systems in low-rise residential occupancies*. (Standard No. 13R). Retrieved from www.nfpa.org

NFPA. (2016). *Standard for the installation of sprinkler systems in one- and two-family dwellings and manufactured homes*. (Standard No. 13D). Retrieved from www.nfpa.org

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UNIT 6: PRESCRIPTIVE DESIGN

TERMINAL OBJECTIVE

The students will be able to:

6.1 Evaluate the accuracy of computations on an International Residential Code (IRC) P2904 prescriptive design worksheet.

ENABLING OBJECTIVES

The students will be able to:

6.1 Verify the accuracy of variables that are used in the IRC P2904 prescriptive design sprinkler worksheet.

6.2 Identify water system additions that might affect the outcome of the prescriptive design formula.

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FEMA

U.S. Fire Administration

UNIT 6:
PRESCRIPTIVE DESIGN

Slide 6-1

TERMINAL OBJECTIVE

Evaluate the accuracy of computations on an International Residential Code (IRC) P2904 prescriptive design worksheet.

Slide 6-2

ENABLING OBJECTIVES

- Verify the accuracy of variables that are used in the IRC P2904 prescriptive design sprinkler worksheet.
- Identify water system additions that might affect the outcome of the prescriptive design formula.

Slide 6-3

I. PRESCRIPTIVE DESIGN



A. Prescriptive design allows the designer to employ a simple step-by-step method to select pipe size, pipe diameter and pipe length for the system.

1. Prescriptive design is recognized by both National Fire Protection Association (NFPA) 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, and International Residential Code (IRC) P2904. It is suitable only for one- and two-family dwellings and townhouses.

2. The prescriptive design method was developed to provide home builders a simple and low-cost alternative to obtaining a hydraulically designed sprinkler system.

B. The prescriptive method accounts for all the design assumptions found in a hydraulically calculated system but uses simple arithmetic and reference tables that account for slight variations in the pipe configuration that might affect flow (e.g., fittings and elbows).

1. Prescriptive designs will always result in a tree distribution design.

2. Prescriptive design tends to be more conservative than hydraulic design, due to the fact that the table values used in the formula are rounded up. Effects of friction loss due to pipe lengths, directional changes and elevation are included in the table values, so the eventual design includes a safety margin that may not appear in a hydraulic design.

3. One important conceptual difference of the prescriptive method from hydraulic design is that the result of the prescriptive design formula determines the **maximum allowable length of pipe between the dwelling service valve and the single most remote sprinkler.** Where hydraulic design establishes pipe size and configuration for the most demanding two simultaneously flowing sprinklers, the output from the prescriptive formula finds only maximum pipe length to **one** sprinkler. The prescriptive approach provides enough **over design** that if the single most remote sprinkler can perform, any two upstream of it should perform adequately.

PRESCRIPTIVE DESIGN (cont'd)

- Pipe is sized by determining available pressure to offset friction loss.
  - Calculation procedure uses available pressure equation.
  - Establishes maximum allowable pipe length.

Slide 6-5

C. Prescriptive installations should be limited to a single pipe material (e.g., chlorinated polyvinyl chloride (CPVC), copper or cross-linked polyethylene (PEX). Materials should not be mixed because of the different interior pipe or tube sizes and roughness.

Once a pipe or tube size is selected, the entire system must be of that size to accommodate the values that have been interpolated in the prescriptive tables.

AVAILABLE PRESSURE EQUATION

$$P_{sup}-PL_{svc}-PL_m-PL_d-PL_e-P_{sp} = P_t$$

- P_{sup} = from water source or pump.
- PL_{svc} = loss in service pipe.
- PL_m = loss through meter.
- PL_d = loss through other devices (softeners, filters, etc.).

Slide 6-6

D. Prescriptive design uses the **available pressure equation,** which results in the pressure available to offset friction loss in the dwelling unit's interior pipe (or the pressure available to supply sprinklers).

1. Available pressure formula:

P_{sup}-PL_{svc}-PL_m-PL_d-PL_e-P_{sp} = P_t

a. P_{sup}: This is the static water pressure available at the point of supply. This may be the connection to the municipal-type water main or (in the case of a non-pressurized tank and pump arrangement) the **minimum** pressure control setting for the pump.

b. PL_{svc}: This is the pressure loss in the water service pipe between the connection and the point where it enters the dwelling. A value is entered from IRC Table P2904.6.2(1), Water Service Pressure Loss, based on the diameter of the pipe and its length.

c. PL_m: This is the pressure loss resulting from the installation of a typical water meter of 5/8-, 3/4- or 1-inch size. If the actual loss is known based on the manufacturer's technical literature, use that value.

d. PL_d: This is the pressure loss due to additional devices being installed in the water supply, such as water softeners, pressure reducing valves (PRVs), backflow preventers, water filters or similar flow restricting devices.

- Device pressure losses must be based on the manufacturer's technical literature. (If one or more of these devices are equipped with a bypass feature that opens when the sprinkler system operates, this value may be entered as zero.)

- If the water service supplies more than one dwelling, add 5 gallons per minute (gpm) to the flow rate to select the pressure loss value from the table.

AVAILABLE PRESSURE EQUATION (cont'd)

P_{sup}-PL_{svc}-PL_m-PL_d-PL_e-P_{sp} = P_t

- PL_e = loss due to elevation.
- P_{sp} = sprinkler operating pressure.
- P_t = available pressure to determine maximum pipe length to most remote sprinkler.

Slide 6-7

e. PL_e: This is the pressure loss due to elevation from the point of supply where the water source pressure was measured and from the elevation of the highest sprinkler.

f. P_{sp}: This is the pressure needed by any individual sprinkler to operate at the coverage area that the designer has selected.

DATA SOURCES

- Water purveyor:
  - Source pressure.
  - Service pipe length and diameter.
  - Meter or backflow prevention requirements.
- Homeowner:
  - Water filters, softeners, other devices.
    - -- Identified by make and model.

Slide 6-8

2. The values that are inserted into the formula are collected from the following:

   a. The water purveyor.

      - Water source pressure.

      - Water service pipe size and length (from street to dwelling unit).

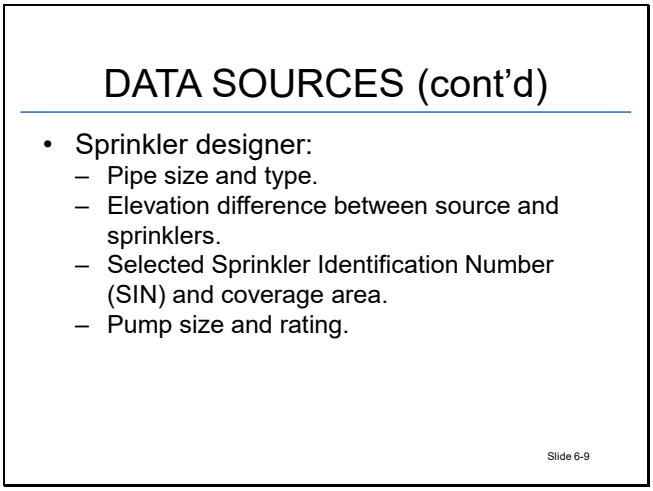
      - Water meter size (if one is required).

- Backflow prevention device (if one is required).

b. The homeowner, contractor or building designer.

- Water filters and softeners, and other flow-restricting devices.

-- These must be identified by make and model to verify their flow restriction values.



c. Sprinkler designer.

- Type and diameter of pipe used in the interior piping.

- Elevation difference, in feet, between the source and the highest sprinkler.

- Selected Sprinkler Identification Number (SIN) and maximum coverage based on the sprinkler. This will provide the required pressure value (P_{sp}).

- Pump rating and output, if used.

3. Once the prescriptive design assumptions are known, the designer may refer to tables that provide equivalent values.

The plan submittal should be accompanied by a worksheet that verifies the design assumptions and arithmetic.

4. The arithmetical result (P_t or **available pressure**) is cross-referenced to a table that provides the maximum length of pipe that may be installed between the point where the water supply enters the dwelling and the most remote sprinkler.

KNOWLEDGE CHECK

What fixed pressure losses are used in the available pressure equation? (Select all that apply.)

A. Loss through meter.
B. Loss due to elevation.
C. Loss through other devices.
D. Loss in service pipe.

Slide 6-10

QUICK COMPARISON

	NFPA 13	NFPA 13R	NFPA 13D/IRC P2904
Scope	All occupancies	Group R to four stories and 60 feet in height	One- and two-family and townhouses
Coverage	Entire building	Occupied spaces	Occupied spaces
Sprinkler design	Control mode, pipe schedule, hydraulic design, minimum 0.1 gallons per minute (gpm)/square foot	Life-safety control mode, four-head design, or 0.05 gpm/square foot	Life-safety control mode, two-head design, or 0.05 gpm/square foot
Sprinklers	All approved types, residential in dwelling unit and adjacent corridor	Residential in dwelling unit and adjacent corridor, other approved types elsewhere	Residential in dwelling unit, other approved types elsewhere
Water demand	System, plus 100 to 500 gpm	± 52 gpm	± 26 gpm
Duration	30 to 120 minutes	30 minutes	7 to 10 minutes
Fire Department Connection (FDC)	Yes, with some exceptions	Yes, if > 2,000 square feet or > one story	Optional

Slide 6-11

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ACTIVITY 6.1

Completing a Residential Sprinkler System Available Pressure Equation

Purpose

Demonstrate the data needed and steps taken to complete an available pressure equation for a prescriptive design.

Direction

Using the blank Available Pressure Worksheet beginning on the following pages and referring to the tables in the Appendix: Residential Sprinkler Prescriptive Design of this unit, you will follow along as the instructor assigns the specific values of the available pressure equation.

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ACTIVITY 6.1 (cont'd)

Available Pressure Worksheet

In the following example, a resident has provided a prescriptive design with the following information:

Design Criteria

1.	Static pressure from water purveyor, well pump or pump discharge (pounds per square inch (psi))		
2.	Number of dwellings served by sprinkler system (add 5 gpm to sprinkler flow rate when more than one dwelling)		
3.	Sprinkler system design flow rate in gpm (minimum 2 sprinklers)		
4.	Dimensions and area of sprinkler coverage		
5.	Minimum pressure required to obtain design flow rate in psi		
6.	Outside diameter water service pipe size in inches		
7.	Water service pipe length in feet		
8.	Water meter (if any) size in inches		
9.	Additional devices (if any): backflow preventer, water softener, filter, purifier		
Count			
	Model/Manufacturer:	Loss	
	Model/Manufacturer:	Loss	
	Model/Manufacturer:	Loss	
	Model/Manufacturer:	Loss	
10.	Loss sum of additional devices (Enter zero if none or if automatic bypass provided)		
11.	Elevation between water source pressure measurement and highest sprinkler in feet		

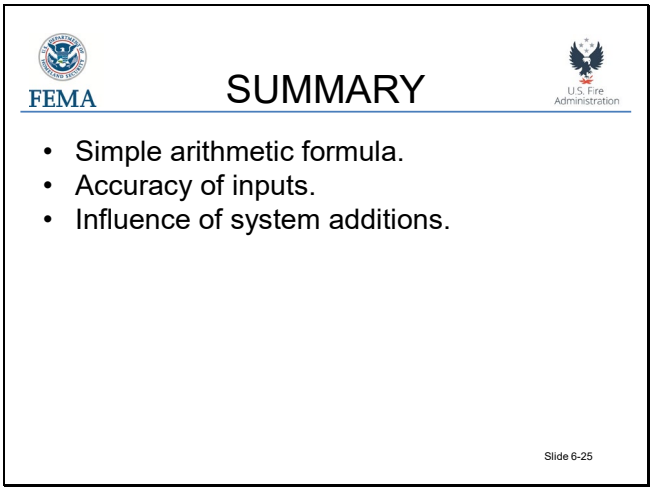
Available Pressure Equation

			Value
Step 1	P_{sup}	Pressure available at water source	
Step 2	PL_{svc}	Pressure loss in water service pipe	
Step 3	PL_m	Pressure loss in water meter	
Step 4	PL_d	Pressure loss due to other devices	
Step 5	PL_e	Pressure loss due to elevation	
Step 6	P_{sp}	Maximum pressure required by sprinkler based on the area of coverage	
Step 7	P_t	Total pressure required in psi ($P_t=P_{sup}-PL_{svc}-PL_m-PL_d-PL_e-P_{sp}$)	

Sprinkler Pipe Material and Size

Material	Diameter	Maximum allowable pipe length from the service value to the most remote sprinkler (feet)
PEX	1-inch	
PEX	3/4-inch	
CPVC	1-inch	
CPVC	3/4-inch	
Type M Copper	1-inch	
Type M Copper	3/4-inch	

II. SUMMARY


FEMA
SUMMARY
U.S. Fire Administration
• Simple arithmetic formula.
• Accuracy of inputs.
• Influence of system additions.
Slide 6-25

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APPENDIX

RESIDENTIAL SPRINKLER PRESCRIPTIVE DESIGN

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Residential Sprinkler Prescriptive Design

As part of the effort to keep residential sprinkler design costs low, the national standards recognize a design method that enables nearly anyone with limited technical skills to create a sprinkler system layout with only a few items of information. This method is called **prescriptive design** because it describes precisely what must be done to achieve compliance with the standard.

Prescriptive design follows all the familiar rules about sprinkler selection, spacing, pipe materials, water supply, hangers, etc., but differs in one key area: rather than using a sophisticated hydraulic calculation formula, simple arithmetic and some reference tables are employed to verify the system meets the design requirements. Rather than sizing pipe based on the hydraulic performance of the available water supply, the pipe is sized (and maximum length established) by the outcome of what is called the **available pressure equation.**

The available pressure equation yields the pressure needed to overcome friction loss due to pipe material and elevation. The resulting pressure can be cross-referenced to a table that provides the maximum allowable length of pipe that can be installed between the point where the water supply enters the building and the most remote single sprinkler on the system. This maximum pipe length is determined by the pipe size and materials.

In order to review and approve a set of plans submitted under the prescriptive design method, the code official should be provided the data inputs that are used in the available pressure equation and the tables from which various values are taken.

Available pressure equation:

$$P_t = P_{sup}\text{-}PL_{svc}\text{-}PL_m\text{-}PL_d\text{-}PL_e\text{-}P_{sp}$$

Where:
P_t = available pressure
P_{sup} = pressure available from the water supply source (or pump)
PL_{svc} = pressure loss in the water service pipe
PL_m = pressure loss through a water meter
PL_d = pressure loss from other devices on the system (water softeners, pressure reducing valves, backflow preventers, water filters or similar flow-restricting devices)

(If one or more of these devices is equipped with a bypass feature that opens when the sprinkler system operates, this value may be entered as zero.)

PL_e = pressure loss due to elevation
P_{sp} = pressure needed by a sprinkler to meet its coverage requirements (as specified in the manufacturer's catalog information)

Available Pressure Equation Inputs

In order to collect accurate inputs, the designer must know the combined flow of the design sprinklers. This value is needed to select accurate pressure loss inputs from the tables. (See extracts on the following pages.)

P_{sup}	This is the static water pressure available at the point of supply. This may be the connection to the municipal-type water main, or (in the case of a non-pressurized tank and pump arrangement) the **minimum** pressure control setting for the pump.
PL_{svc}	This is the pressure loss in the water service pipe between the connection and the point where it enters the dwelling. A value is entered from the Water Service Pressure Loss table based on the diameter of the pipe and its length.
PL_m	This is the pressure loss resulting from the installation of a typical water meter of 5/8-, 3/4- or 1-inch size. If the actual loss is known based on the manufacturer's technical literature, use that value.
PL_d	This is the pressure loss due to additional devices being installed in the water supply, such as water softeners, pressure reducing valves (PRVs), backflow preventers, water filters or similar flow-restricting devices. Device pressure losses must be based on the manufacturer's technical literature. (If one or more of these devices is equipped with a bypass feature that opens when the sprinkler system operates, this value may be entered as zero.) If the water service supplies more than one dwelling, add 5 gpm to the flow rate to select the pressure loss value from the table.
PL_e	This is the pressure loss due to elevation from the point of supply **where the water source pressure was measured** and the elevation of the highest sprinkler.
P_{sp}	This is the pressure needed by any individual sprinkler to operate at the coverage area that the designer has selected. This information can be obtained from the sprinkler manufacturer's technical bulletin.

Once the input values are in the equation, solve for P_t. P_t is the residual pressure available to supply the sprinkler system.

With the P_t value, the designer can refer to another set of tables that, based on pipe size and materials, provides the allowable length of pipe between the point where the system enters the building and the most remote sprinkler.

Note that in the prescriptive pipe-sizing method, one needs to know the combined flow from the design sprinklers, but the allowable pipe length is applicable only to the most remote sprinkler. This is based on the hydraulic characteristic that if the most remote sprinkler can be supplied adequately (volume and pressure) the sprinklers upstream (between it and the source) will be supplied adequately.

Extracts from Prescriptive Design Tables

The following examples are extracted from the prescriptive design tables for illustration only. They do not represent the entire table.

Water Service Pressure Loss Table for PL_{svc}

Flow rate (gpm)	3/4-inch Water Service Pressure Loss (psi)				1-inch Water Service Pressure Loss (psi)				1 1/4-inch Water Service Pressure Loss (psi)			
	Length of service pipe (feet)				Length of service pipe (feet)				Length of service pipe (feet)			
	40 or less	41 to 75	76 to 100	101 to 150	40 or less	41 to 75	76 to 100	101 to 150	40 or less	41 to 75	76 to 100	101 to 150
8	5.1	8.7	11.8	17.4	1.5	2.5	3.4	5.1	0.6	1.0	1.3	1.9
10	7.7	13.1	17.8	26.3	2.3	3.8	5.2	7.7	0.8	1.4	2.0	2.9
18	22.9	NP	NP	NP	6.7	11.4	15.4	22.7	2.5	4.3	5.8	8.6
20	27.8	NP	NP	NP	8.1	13.8	18.7	27.6	3.1	5.2	7.0	10.4
28	NP	NP	NP	NP	15.1	25.7	NP	NP	5.7	9.7	13.1	19.4
34	NP	NP	NP	NP	21.7	NP	NP	NP	8.2	13.9	18.8	NP

NP = not permitted; must find alternate solution.

Minimum Water Meter Pressure Loss for PL_m (To be used only if manufacturer's pressure loss data is not known)

Flow rate (gpm)	5/8-inch Water Meter Pressure Loss (psi)	3/4-inch Water Meter Pressure Loss (psi)	1-inch Water Meter Pressure Loss (psi)
8	2	1	1
10	3	1	1
20	11	4	2
28	NP	6	2
34	NP	8	3

NP = not permitted; must find alternate solution.

Elevation Loss for PL_e
(Difference from where the water source pressure was measured)

Elevation (feet)	Pressure Loss (psi)
5	2.2
10	4.4
15	6.5
20	8.7
25	10.9
30	13

Allowable Pipe Length for 1-inch PEX for P_t
(Table values are allowable length of pipe from service valve to farthest sprinkler)

Flow Rate (gpm)	Available Pressure = P_t								
	15	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**
8	314	418	523	628	732	837	941	1,046	1,151
10	208	277	346	415	485	554	623	692	761
20	58	77	96	115	134	154	173	192	211
28	31	41	52	62	72	82	93	103	113
34	22	29	36	43	50	58	65	72	79

Allowable Pipe Length for 3/4-inch PEX for P_t
(Table values are allowable length of pipe from service valve to farthest sprinkler)

Flow Rate (gpm)	Available Pressure = P_t								
	15	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**
8	93	123	154	185	216	247	278	309	339
10	74	99	124	149	174	199	223	248	273
20	17	23	28	34	40	45	51	57	62
28	NP	NP	15	18	21	24	27	30	33
34	NP	NP	NP	NP	NP	17	19	21	23

NP = not permitted; must find alternate solution.

Allowable Pipe Length for 1-inch CPVC for P_t
(Table values are allowable length of pipe from service valve to farthest sprinkler)

Flow Rate (gpm)	Available Pressure = Pt								
	15	20	25	30	35	40	45	50	55
8	1,049	1,398	1,748	2,098	2,447	2,797	3,146	3,496	3,845
10	694	925	1,157	1,388	1,619	1,851	2,082	2,314	2,545
20	193	257	321	385	449	513	578	642	706
28	103	138	172	207	241	275	310	344	379
34	72	96	120	144	168	192	216	240	265

Allowable Pipe Length for 1-inch Type M Copper for P_t
(Table values are allowable length of pipe from service valve to farthest sprinkler)

Flow Rate (gpm)	Available Pressure = Pt								
	15	20	25	30	35	40	45	50	55
8	806	1,075	1,343	1,612	1,881	2,149	2,418	2,687	2,955
10	533	711	889	1,067	1,245	1,442	1,600	1,778	1,956
20	148	197	247	296	345	395	444	493	543
28	79	106	132	159	185	212	238	265	291
34	55	74	92	111	129	148	166	185	203

Allowable Pipe Length for 3/4-inch CPVC for P_t
(Table values are allowable length of pipe from service valve to farthest sprinkler)

Flow Rate (gpm)	Available Pressure = Pt								
	15	20	25	30	35	40	45	50	55
8	348	465	581	697	813	929	1,045	1,161	1,278
10	231	307	384	461	538	615	692	769	845
20	64	85	107	128	149	171	192	213	235
28	34	46	57	69	80	92	103	114	126
34	24	32	40	48	56	64	72	80	88

Allowable Pipe Length for 3/4-inch Type M Copper for P_t
(Table values are allowable length of pipe from service valve to farthest sprinkler)

Flow Rate (gpm)	Available Pressure = Pt								
	15	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**
8	217	289	361	434	506	578	650	723	795
10	143	191	239	287	335	383	430	478	526
20	40	53	66	80	93	106	119	133	146
28	21	28	36	43	50	57	64	71	78
34	NP	20	25	30	35	40	45	50	55

NP = not permitted; must find alternate solution.

Available Pressure Equation

Design Criteria

Steps	Description		Value	
1	Static pressure from water purveyor, well pump or pump discharge (psi)			psi
2	Number of dwellings served by sprinkler system (add 5 gpm to sprinkler flow rate when more than one dwelling)			
3	Sprinkler system design flow rate in gpm (minimum 1, maximum 2 sprinklers)			
	Design sprinkler(s): _____x _____ gpm =			gpm
	Or, design sprinkler(s): (_____x _____ gpm) + 5 gpm =			gpm
4	Dimensions and area of sprinkler coverage (16x16)			$feet^2$
5	Minimum pressure required to obtain design flow rate in psi			psi
6	Outside diameter water service pipe size in inches			inch
7	Water service pipe length in feet			feet
8	Water meter (if any) size in inches			inch
9	Additional devices (if any): backflow preventer, water softener, filter, purifier			
	Count			
		Model/Manufacturer:		psi
		Model/Manufacturer:		psi
		Model/Manufacturer:		psi
		Model/Manufacturer:		psi
10	Loss sum of additional devices (enter zero if none or if automatic bypass provided)			psi
11	Elevation between water source pressure measurement and highest sprinkler in feet			feet

Available Pressure Equation

Steps	P	Description	Value
Step 1	P_{sup}	Pressure available at water source	
Step 2	PL_{svc}	Pressure loss in water service pipe	
Step 3	PL_m	Pressure loss in water meter	
Step 4	PL_d	Pressure loss due to other devices	
Step 5	PL_e	Pressure loss due to elevation	
Step 6	P_{sp}	Minimum pressure required by sprinkler based on the area of coverage	
Result	P_t	Total pressure required in psi ($P_t = P_{sup}-PL_{svc}-PL_m-PL_d-PL_e-P_{sp}$)	

Sprinkler Pipe Material and Size

Material	Diameter	Maximum allowable pipe length from the service valve to the most remote sprinkler (feet)
PEX	1-inch	
PEX	3/4-inch	
CPVC	1-inch	
CPVC	3/4-inch	
Type M Copper	1-inch	
Type M Copper	3/4-inch	

Available Pressure Equation (Training Sample Only)

In the following example, a resident has provided a prescriptive design with the following information.

Design Criteria

Steps	Description		Value
1	Static pressure from water purveyor, well pump or pump discharge (psi)		**64** psi
2	Number of dwellings served by sprinkler system (add 5 gpm to sprinkler flow rate when more than one dwelling)		**1**
3	Sprinkler system design flow rate in gpm (minimum 1, maximum 2 sprinklers)		
	Design sprinkler(s): _____x _____ gpm =		**28** gpm
	Or, design sprinkler(s): (_____x _____ gpm) + 5 gpm =		gpm
4	Dimensions and area of sprinkler coverage (16 x 16)		**256** feet^2
5	Minimum pressure required to obtain design flow rate in psi		**7** psi
6	Outside diameter water service pipe size in inches		**1** inch
7	Water service pipe length in feet		**26** feet
8	Water meter (if any) size in inches		**1** inch
9	Additional devices (if any) backflow preventer, water softener, filter, purifier		**0**
	Count		
	0	Model/Manufacturer:	psi
	0	Model/Manufacturer:	psi
	0	Model/Manufacturer:	psi
	0	Model/Manufacturer:	psi
10	Loss sum of additional devices (enter zero if none of if automatic bypass provided)		**0** psi
11	Elevation between water source pressure measurement and highest sprinkler in feet		**20** feet

Available Pressure Equation

Steps	P	Description	Value
Step 1	P_{sup}	Pressure available at water source	**64**
Step 2	PL_{svc}	Pressure loss in water service pipe	**15.1**
Step 3	PL_m	Pressure loss in water meter	**2**
Step 4	PL_d	Pressure loss due to other devices	**0**
Step 5	PL_e	Pressure loss due to elevation	**8.7**
Step 6	P_{sp}	Minimum pressure required by sprinkler based on the area of coverage	**7**
Result	P_t	Total pressure required in psi ($P_t = P_{sup}-PL_{svc}-PL_m-PL_d-PL_e-P_{sp}$)	**31.2**

Sprinkler Pipe Material and Size

With 31.2 psi available pressure, the maximum allowable pipe length from the service valve to the most remote sprinkler, based on pipe material and size, is:

Material	Diameter	Maximum allowable pipe length from the service valve to the most remote sprinkler (feet)
PEX	1-inch	**62**
PEX	3/4-inch	**18**
CPVC	1-inch	**207**
CPVC	3/4-inch	**69**
Type M Copper	1-inch	**159**
Type M Copper	3/4-inch	**43**

UNIT 7: CONCLUSION

TERMINAL OBJECTIVE

The students will be able to:

7.1 Verify compliance with national design and installation standards, given a set of plans and hydraulic calculations.

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FEMA

U.S. Fire Administration

UNIT 7: CONCLUSION

Slide 7-1

TERMINAL OBJECTIVE

Verify compliance with national design and installation standards, given a set of plans and hydraulic calculations.

Slide 7-2

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ACTIVITY 7.1

Plans Review Assessment

Purpose

Verify compliance with national design and installation standards for a given set of plans and hydraulic calculations.

Directions

1. You will refer to this unit's Appendix A: Yellow House Residential Sprinkler Plans for sprinkler drawings and hydraulic calculations. Refer also to the sprinkler manufacturer data sheets from this unit's Appendix B: Tyco Manufacturer Catalog Information.

2. Based on the information provided, answer the following questions in your group:

   a. Are all the sprinklers in the living room suitable for residential application? Why or why not?

   b. Is the Fire Department Connection (FDC) and piping installed in accordance with national standards or the manufacturer's recommended installation practices? Why or why not?

   c. Is the main control valve and piping installed in accordance with national standards or the manufacturer's recommended installation practices? Why or why not?

d. Do all pipe sizes match the sprinkler plan general notes or the calculations? Why or why not?

e. Do all pipe types match the sprinkler plan general notes or the calculations? Why or why not?

f. Are all elevation design assumptions addressed in the hydraulic calculations? Why or why not?

g. Is the water supply the correct amount? Why or why not?

h. Are the “General Notes” regarding the pressure testing correct on the drawings? Why or why not?

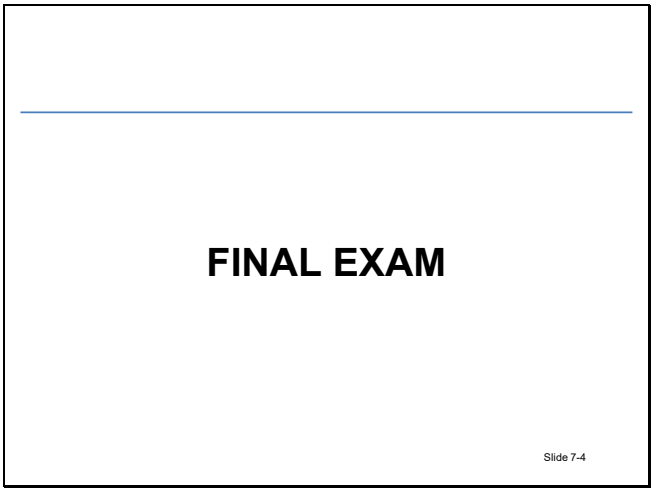
i. Is all sprinkler spacing in the kitchen in accordance with the manufacturer's recommended installation practices? Why or why not?

j. Is sprinkler coverage on the first floor in accordance with national standards or the manufacturer's recommended installation practices? Why or why not?

k. For the sprinkler spacing shown, is the flow and pressure value correct in the hydraulic calculations? Why or why not?

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I. FINAL EXAM

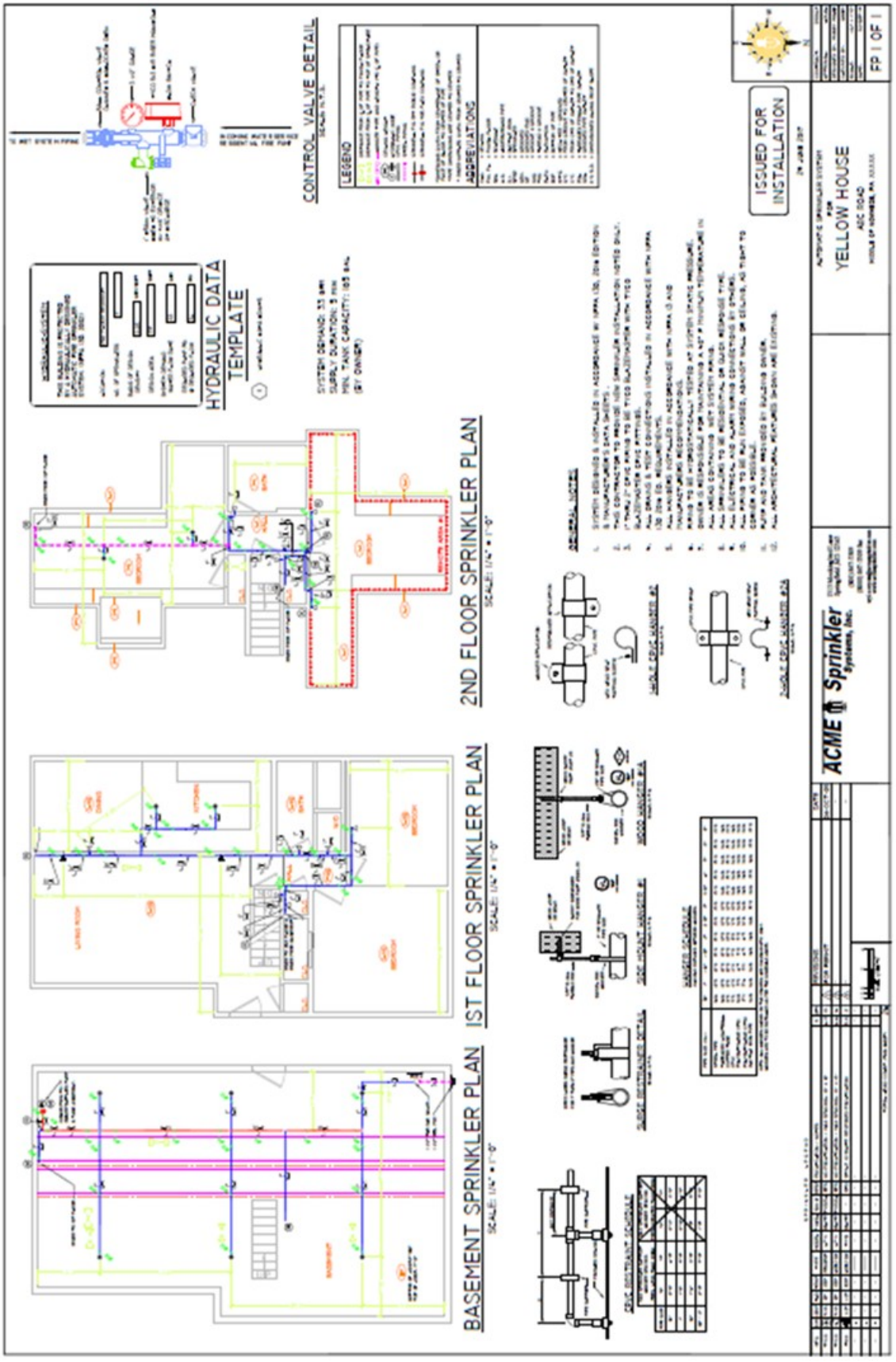


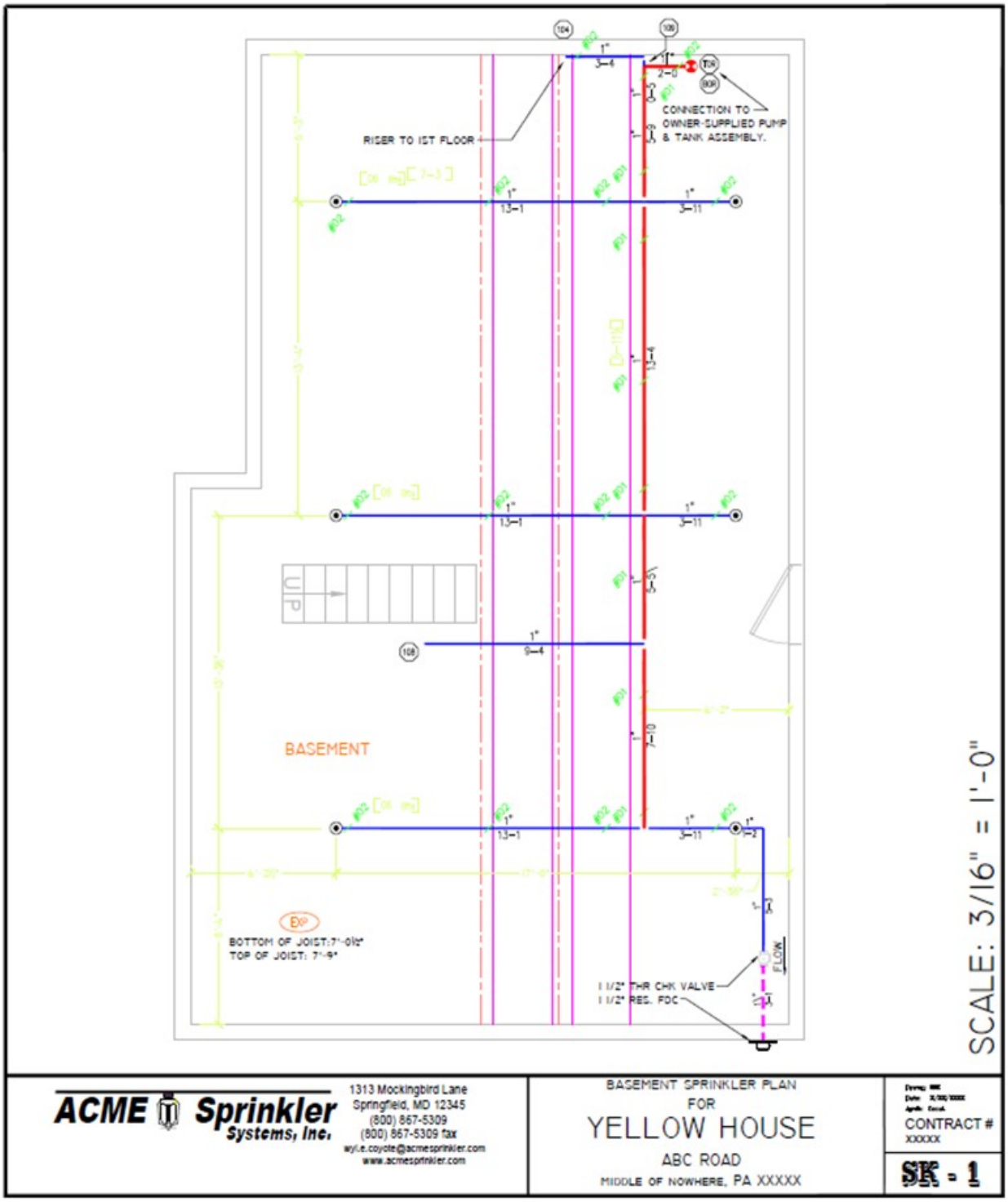
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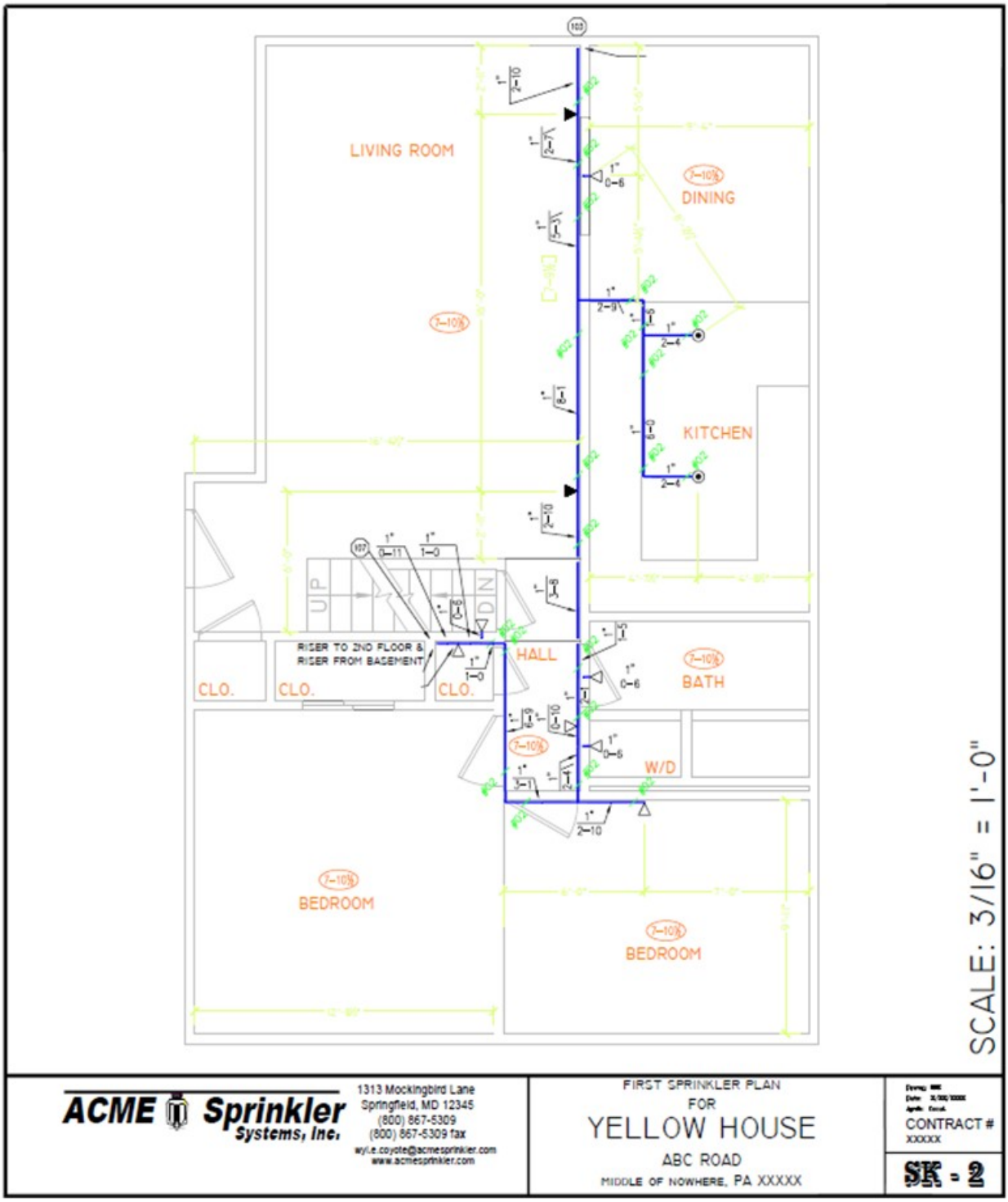
APPENDIX A

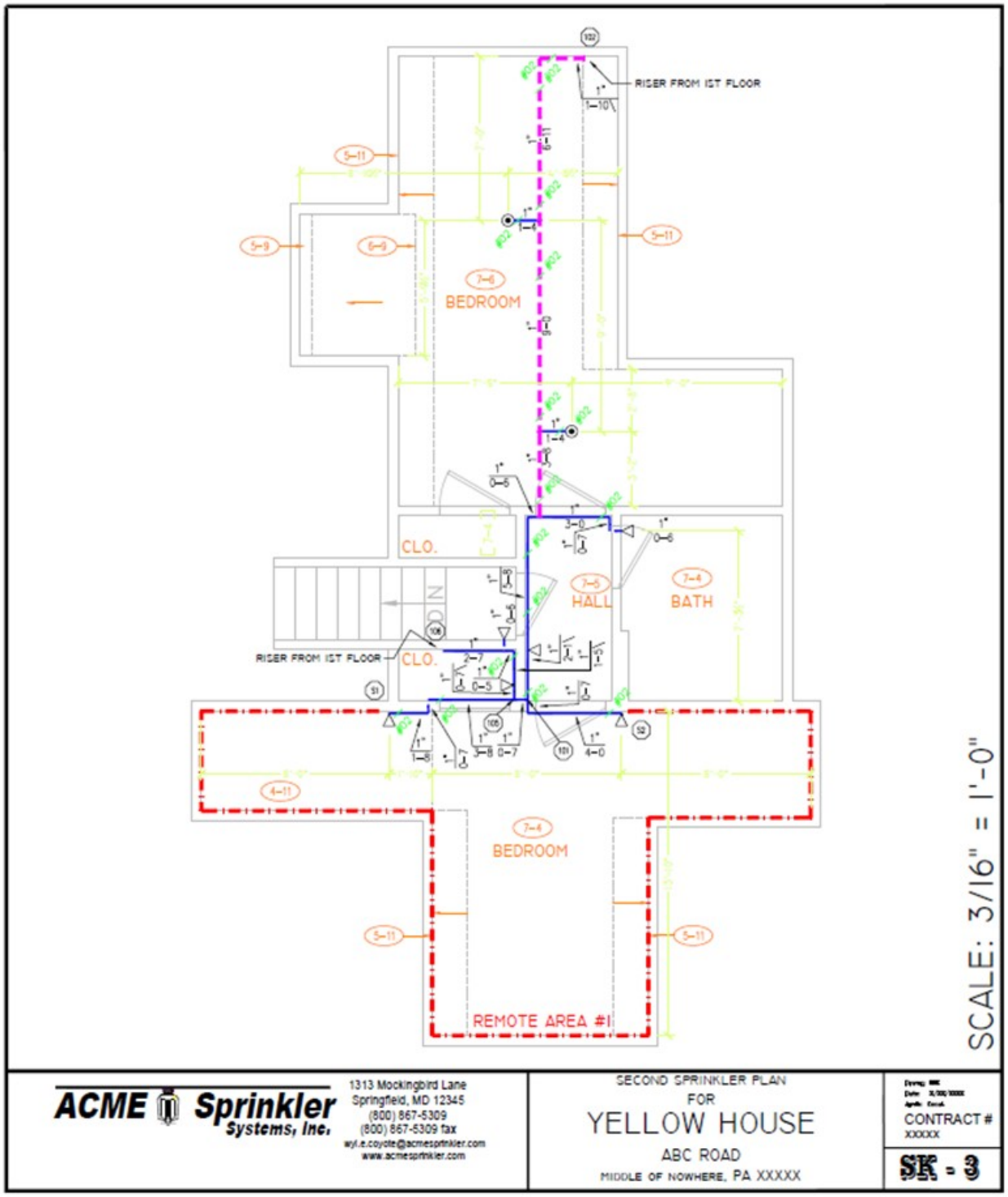
YELLOW HOUSE RESIDENTIAL SPRINKLER PLANS

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CONTROL VALVE DETAIL
LEGEND
ABBREVIATIONS
HYDRAULIC DATA TEMPLATE
2ND FLOOR SPRINKLER PLAN
IST FLOOR SPRINKLER PLAN
BASEMENT SPRINKLER PLAN
ISSUED FOR INSTALLATION
YELLOW HOUSE
ACME Sprinkler Systems, Inc.
FP 1 OF 1


RISER TO 1ST FLOOR
CONNECTION TO OWNER-SUPPLIED PUMP & TANK ASSEMBLY.
BASEMENT
UP
EXP
BOTTOM OF JOIST: 7'-0½"
TOP OF JOIST: 7'-9"
1 1/2" THR CHK VALVE
1 1/2" RES. FDC
FLOW
SCALE: 3/16" = 1'-0"
ACME Sprinkler Systems, Inc.
1313 Mockingbird Lane
Springfield, MD 12345
(800) 867-5309
(800) 867-5309 fax
wyl.e.coyote@acmesprinkler.com
www.acmesprinkler.com
BASEMENT SPRINKLER PLAN
FOR
YELLOW HOUSE
ABC ROAD
MIDDLE OF NOWHERE, PA XXXXX
CONTRACT # XXXXX
SK - 1


LIVING ROOM
DINING
KITCHEN
HALL
BATH
W/D
BEDROOM
BEDROOM
CLO.
CLO.
CLO.
UP
DN
RISER TO 2ND FLOOR &
RISER FROM BASEMENT
SCALE: 3/16" = 1'-0"
ACME Sprinkler Systems, Inc.
1313 Mockingbird Lane
Springfield, MD 12345
(800) 867-5309
(800) 867-5309 fax
wile.coyote@acmesprinkler.com
www.acmesprinkler.com
FIRST SPRINKLER PLAN
FOR
YELLOW HOUSE
ABC ROAD
MIDDLE OF NOWHERE, PA XXXXX
CONTRACT #
XXXXX
SK - 2


RISER FROM 1ST FLOOR
BEDROOM
CLO.
HALL
BATH
CLO.
RISER FROM 1ST FLOOR
BEDROOM
REMOTE AREA #1
SCALE: 3/16" = 1'-0"
ACME Sprinkler Systems, Inc.
1313 Mockingbird Lane
Springfield, MD 12345
(800) 867-5309
(800) 867-5309 fax
wyl.e.coyote@acmesprinkler.com
www.acmesprinkler.com
SECOND SPRINKLER PLAN
FOR
YELLOW HOUSE
ABC ROAD
MIDDLE OF NOWHERE, PA XXXXX
CONTRACT #
XXXXX
SK - 3

ACME Sprinkler Systems, Inc.
1313 Mockingbird Lane
Springfield, MD 12345
800-867-5309

Job Name	:	YELLOW HOUSE
Building	:	YELLOW HOUSE
Location	:	ABC Road Middle of Nowhere, PA XXXXX
System	:	1
Contract	:	xxxxx
Data File	:	YELLOW Incorrect.WXF

Computer Programs by Hydratec Inc. Route 111 Windham N.H. USA 03087

ACME Sprinkler Systems, Inc.
YELLOW HOUSE

Page 1
Date 28-SEP-17

HYDRAULIC DESIGN INFORMATION SHEET

Name - YELLOW HOUSE Date - 30-SEP-09
Location - ABC Road Middle of Nowhere, PA XXXXX
Building - YELLOW HOUSE System No. - 1
Contractor - OWNER Contract No. - xxxxx
Calculated By - MICKEY MOUSE Drawing No. - FP 1 OF 1
Construction: (X) Combustible ( ) Non-Combustible Ceiling Height 7'-4"
OCCUPANCY - RESIDENTIAL

SYSTEM

Type of Calculation: ( )NFPA 13 Residential ( )NFPA 13R (X)NFPA 13D
Number of Sprinklers Flowing: ( )1 (X)2 ( )4 ( )
( )Other
( )Specific Ruling Made by Date

DESIGN

Listed Flow at Start Point - 16 Gpm System Type
Listed Pres. at Start Point - 10.1 Psi (X) Wet ( ) Dry
MAXIMUM LISTED SPACING 16 x 16 ( ) Deluge ( ) PreAction
Domestic Flow Added - 0 Gpm Sprinkler or Nozzle
Additional Flow Added - 0 Gpm Make TYCO Model LF-II
Elevation at Highest Outlet - 21'-0"Feet Size 1/2" K-Factor 4.4
Note: Temperature Rating 155°

Calculation Summary: Gpm Required 33 Psi Required 20 AT PUMP DISCHARGE
C-Factor Used: Overhead 150 Underground N/A

WATER SUPPLY

Water Flow Test:
Date of Test - N/A
Time of Test - N/A
Static (Psi) - N/A
Residual (Psi) - N/A
Flow (Gpm) - N/A
Elevation - N/A

Pump Data:
Rated Cap.
@ Psi
Elev.
Other

Tank or Reservoir:
Cap.
Elev. 0'-0"

Well
Proof Flow Gpm

PLAY

Location: N/A

Source of Information: N/A

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Water Supply Curve (C)

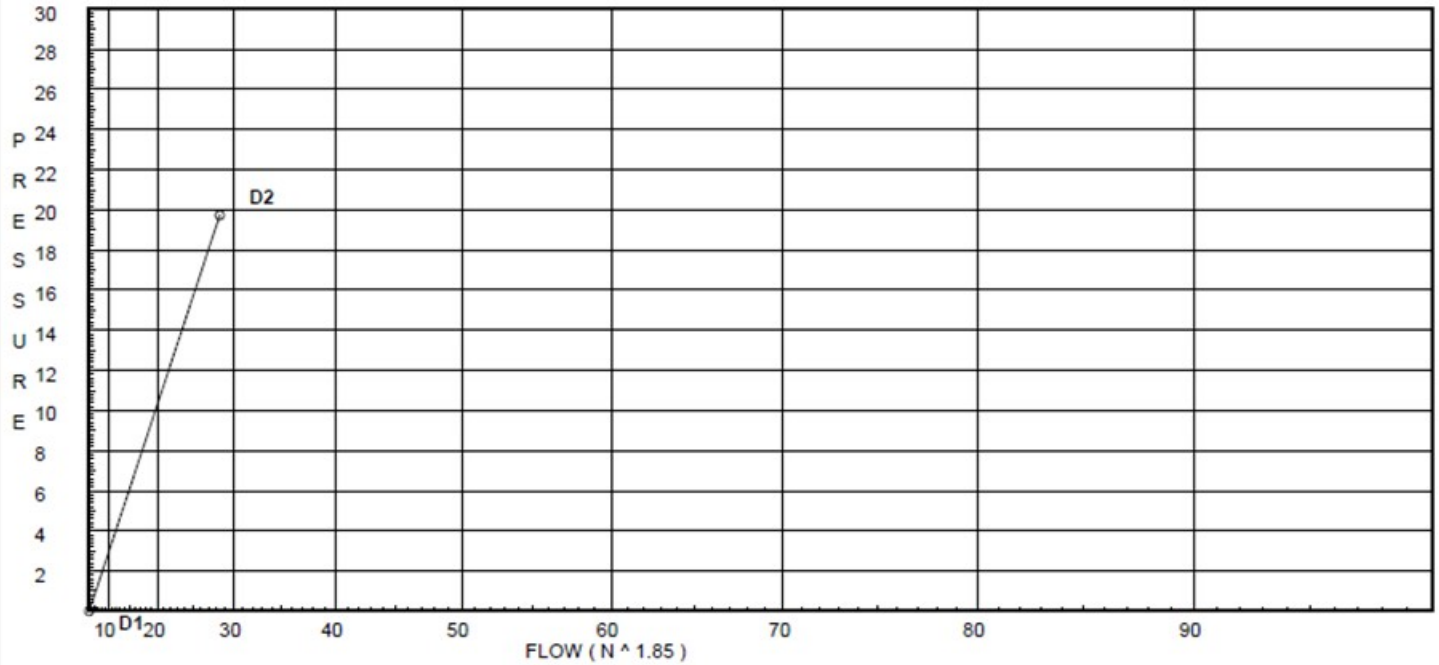
ACME Sprinkler Systems, Inc.

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Demand:

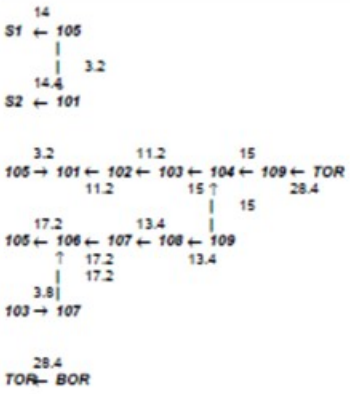
D1 - Elevation	:	
D2 - System Flow	:	28.3775
D2 - System Pressure	:	19.732
Hose (Adj City)	:	
Hose (Demand)	:	
D3 - System Demand	:	28.3775
Safety Margin	:	



Flow Diagram

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Fittings Used Summary

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Fitting Legend Abbrev.	Name	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20	24
Fsp	Flow Switch Potter VSR	Fitting generates a Fixed Loss Based on Flow																			
N *	CPVC 90'Ell Harvel-Spears		7	7	8	9	11	12	13	0	0	0	0	0	0	0	0	0	0	0	0
O *	CPVC Tee - Branch	3	3	5	6	8	10	12	15	0	0	0	0	0	0	0	0	0	0	0	0
R *	CPVC Coupling Tee - Run	1	1	1	1	1	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0
S	NFPA 13 Swing Check Valve	4	5	5	7	9	11	14	16	19	22	27	32	45	55	65	76	87	98	109	130

Units Summary

Diameter Units	Inches
Length Units	Feet
Flow Units	US Gallons per Minute
Pressure Units	Pounds per Square Inch

Note: Fitting Legend provides equivalent pipe lengths for fittings types of various diameters. Equivalent lengths shown are standard for actual diameters of Sched 40 pipe and CFactors of 120 except as noted with *. The fittings marked with a * show equivalent lengths values supplied by manufacturers based on specific pipe diameters and CFactors and they require no adjustment. All values for fittings not marked with a * will be adjusted in the calculation for CFactors of other than 120 and diameters other than Sched 40 per NFPA.

Flow Summary - NFPA 2016

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SUPPLY ANALYSIS

Node at Source	*Static Pressure*	*Residual Pressure*	*Flow*	*Available Pressure*	*Total Demand*	*Required Pressure*

NODE ANALYSIS

Node Tag	*Elevation*	*Node Type*	*Pressure at Node*	*Discharge at Node*	*Notes*
S1	0.0	4.4	10.1	13.98	
S2	0.0	4.4	10.7	14.39	
105	0.0		11.6		
101	0.0		11.59		
102	0.0		13.29		
103	0.0		13.6		
104	0.0		14.22		
109	0.0		15.43		
106	0.0		12.58		
107	0.0		13.27		
108	0.0		13.77		
TOR	0.0		15.84		
BOR	0.0		19.73		

Final Calculations - Hazen-Williams - 2017

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Node1 to Node2	Elev1 Elev2	K Fact	Qa Qt	Nom Act	Fitting or Eqv.	Ln.	Pipe Ftng's Total	CFact Pf/Ft	Pt Pe Pf	******* Notes ******
S1	0	4.40	13.98	1	4N	28.0	8.833	150	10.100	
to					1O	5.0	34.000		0.0	
105	0		13.98	1.101	1R	1.0	42.833	0.0351	1.503	Vel = 4.71
			0.0							
105			13.98						11.603	K Factor = 4.10
S2	0	4.40	14.39	1	2N	14.0	5.000	150	10.702	
to					1O	5.0	19.000		0.0	
101	0		14.39	1.101		0.0	24.000	0.0370	0.889	Vel = 4.85
			0.0							
101			14.39						11.591	K Factor = 4.23
105	0		-3.18	1	1O	5.0	0.583	150	11.603	
to						0.0	5.000		0.0	
101	0		-3.18	1.101		0.0	5.583	-0.0021	-0.012	Vel = 1.07
101	0		14.39	1	5N	35.0	29.750	150	11.591	
to					1O	5.0	43.000		0.0	
102	0		11.21	1.101	3R	3.0	72.750	0.0233	1.697	Vel = 3.78
102	0		0.0	1	1O	5.0	8.333	150	13.288	
to						0.0	5.000		0.0	
103	0		11.21	1.101		0.0	13.333	0.0233	0.311	Vel = 3.78
103	0		3.79	1	1N	7.0	8.625	150	13.599	
to						0.0	7.000		0.0	
104	0		15.0	1.101		0.0	15.625	0.0400	0.625	Vel = 5.05
104	0		0.0	1	3N	21.0	4.167	150	14.224	
to					1O	5.0	26.000		0.0	
109	0		15.0	1.101		0.0	30.167	0.0399	1.205	Vel = 5.05
109	0		13.38	1.25	1N	8.0	2.000	150	15.429	
to						0.0	8.000		0.0	
TOR	0		28.38	1.394		0.0	10.000	0.0412	0.412	Vel = 5.97
			0.0							
TOR			28.38						15.841	K Factor = 7.13
105	0		17.16	1	2N	14.0	5.083	150	11.603	
to						0.0	14.000		0.0	
106	0		17.16	1.101		0.0	19.083	0.0513	0.979	Vel = 5.78
106	0		0.0	1	1O	5.0	8.333	150	12.582	
to						0.0	5.000		0.0	
107	0		17.16	1.101		0.0	13.333	0.0512	0.683	Vel = 5.78
107	0		-3.78	1	1N	7.0	8.625	150	13.265	
to						0.0	7.000		0.0	
108	0		13.38	1.101		0.0	15.625	0.0323	0.505	Vel = 4.51
108	0		0.0	1	1N	7.0	34.292	150	13.770	
to					2O	10.0	17.000		0.0	
109	0		13.38	1.101		0.0	51.292	0.0323	1.659	Vel = 4.51
			0.0							
109			13.38						15.429	K Factor = 3.41
103	0		-3.78	1	5N	35.0	48.792	150	13.599	
to					3O	15.0	58.000		0.0	
107	0		-3.78	1.101	8R	8.0	106.792	-0.0031	-0.334	Vel = 1.27
			0.0							

Final Calculations - Hazen-Williams - 2017

ACME Sprinkler Systems, Inc.
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Node1 to Node2	Elev1 Elev2	K Fact	Qa Qt	Nom Act	Fitting or Eqv.	Ln.	Pipe Ftng's Total	CFact Pf/Ft	Pt Pe Pf	******* Notes ******
107			-3.78						13.265	K Factor = -1.04
TOR	0		28.38	1.25	1S	7.353	6.958	120	15.841	
to					1Fsp	0.0	7.353		3.000	* Fixed loss = 3
BOR	0		28.38	1.394		0.0	14.311	0.0623	0.891	Vel = 5.97
			0.0							
BOR			28.38						19.732	K Factor = 6.39

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APPENDIX B

TYCO MANUFACTURER CATALOG INFORMATION

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tyco Fire Protection Products

Worldwide Contacts | www.tyco-fire.com

RAPID RESPONSE Series LFII Residential 4.9 K-factor Pendent Sprinkler Wet Pipe and Dry Pipe Systems

General Description

TYCO RAPID RESPONSE Series LFII Residential 4.9K Pendent and Recessed Pendent Sprinklers (TY2234) are decorative, fast response, frangible bulb sprinklers designed for use in residential occupancies such as homes, apartments, dormitories, and hotels. When aesthetics and optimized flow characteristics are the major consideration, the Series LFII Residential Sprinklers (TY2234) should be the first choice.

The Series LFII Residential Sprinklers are intended for use in the following scenarios:

- wet and dry pipe residential sprinkler systems for one- and two-family dwellings and mobile homes per NFPA 13D
- wet and dry pipe residential sprinkler systems for residential occupancies up to and including four stories in height per NFPA 13R
- wet and dry pipe sprinkler systems for the residential portions of any occupancy per NFPA 13

The recessed version of the Series LFII Residential Sprinklers is intended for use in areas with finished ceilings. It employs a two-piece Style 20 Recessed Escutcheon. The Recessed Escutcheon provides 1/4 inch (6,4 mm) of recessed adjustment or up to 1/2 inch (12,7 mm) of total adjustment from the flush ceiling position. The adjustment provided by the Recessed Escutcheon reduces the accuracy to which the pipe drops to the sprinklers must be cut.

IMPORTANT

Always refer to Technical Data Sheet TFP700 for the "INSTALLER WARNING" that provides cautions with respect to handling and installation of sprinkler systems and components. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in a fire situation or cause it to operate prematurely.

The Series LFII Residential Sprinklers have been designed with heat sensitivity and water distribution characteristics proven to help in the control of residential fires and to improve the chance for occupants to escape or be evacuated.

Dry Pipe System Application

The Series LFII Residential Pendent and Recessed Pendent Sprinklers offers a laboratory approved option for designing dry pipe residential sprinkler systems, whereas, most residential sprinklers are laboratory approved for wet systems only.

Through extensive testing, it has been determined that the number of design sprinklers (hydraulic design area) for the Series LFII Residential Pendent and Recessed Pendent Sprinklers (TY2234) need not be increased over the number of design sprinklers (hydraulic design area) as specified for wet pipe sprinkler systems, as is accustomed for density/area sprinkler systems designed per NFPA 13.

Consequently, the Series LFII Residential Sprinklers offer the features of non-water filled pipe in addition to not having to increase the number of design sprinklers (hydraulic design area) for systems designed to NFPA 13, 13D, or 13R.

NOTICE

The Series LFII Residential Pendent and Recessed Pendent Sprinklers (TY2234) described herein must be installed and maintained in compliance with this document and the applicable standards of the National Fire Protection Association (NFPA), in addition to the standards of any authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. Contact the installing contractor or product manufacturer with any questions.



NSF

Sprinkler Identification Number (SIN)

TY2234

Technical Data

Approvals

UL Listed (for use with wet pipe and dry pipe systems)

C-UL Listed (for use only with wet pipe systems)

Certified to all requirements of NSF/ANSI 61

(Refer to the Design Criteria section for details on these approvals.)

Maximum Working Pressure

175 psi (12,1 bar)

Discharge Coefficient

K=4.9 gpm/psi$^{1/2}$ (70,6 lpm/bar$^{1/2}$)

Temperature Rating

155°F (68°C) or 175°F (79°C)

Finishes

Natural Brass, Pure White, Signal White, or Chrome Plated

Physical Characteristics

Frame	Brass
Button	Copper
Sealing Assembly	Beryllium Nickel w/ TEFLON
Bulb (3 mm)	Glass
Compression Screw	Bronze
Deflector	Bronze

TFP400
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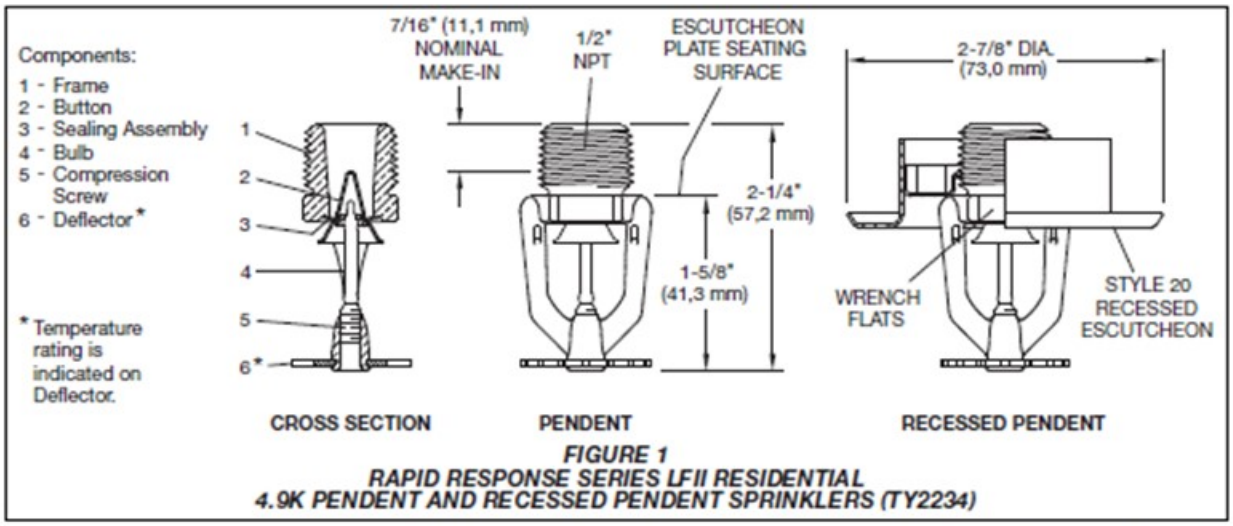


FIGURE 1
RAPID RESPONSE SERIES LFII RESIDENTIAL 4.9K PENDENT AND RECESSED PENDENT SPRINKLERS (TY2234)

Operation

The glass bulb contains a fluid that expands when exposed to heat. When the rated temperature is reached, the fluid expands sufficiently to shatter the glass bulb, allowing the sprinkler to activate and flow water.

Design Criteria

The TYCO RAPID RESPONSE Series LFII Residential 4.9K Pendent and Recessed Pendent Sprinklers are UL and C-UL Listed for installation in accordance with this section.

Residential Sprinkler Design Guide
When conditions exist that are outside the scope of the provided criteria, refer to the Residential Sprinkler Design Guide TFP490 for the manufacturer's recommendations that may be acceptable to the local authority having jurisdiction.

System Types
Per the UL Listing, wet pipe and dry pipe systems may be utilized. Per the C-UL Listing, only wet pipe systems may be utilized.

Refer to Technical Data Sheet TFP485 for the use of residential sprinklers in residential dry pipe systems.

Ceiling Types
Smooth flat horizontal, or beamed, or sloped, in accordance with the 2013 Edition of NFPA 13D, 13R, or 13, as applicable.

Hydraulic Design (NFPA 13D and 13R)
For systems designed to NFPA 13D or NFPA 13R, the minimum required sprinkler flow rates are given in Tables A and B as a function of temperature rating and the maximum allowable coverage areas. The sprinkler flow rate is the minimum required discharge from each of the total number of "design sprinklers" as specified in NFPA 13D or NFPA 13R. The number of "design sprinklers" specified in NFPA 13D and 13R for wet pipe systems is to be applied when designing dry pipe systems.

Hydraulic Design (NFPA 13)
For systems designed to NFPA 13, the number of design sprinklers is to be the four most hydraulically demanding sprinklers. The minimum required discharge from each of the four sprinklers is to be the greater of the following:

- The flow rates given in Table A or B as a function of temperature rating and the maximum allowable coverage area.
- A minimum discharge of 0.1 gpm/ft^2 over the "design area" comprised of the four most hydraulically demanding sprinklers for actual coverage areas protected by the four sprinklers.

The number of design sprinklers specified in NFPA 13 for wet pipe systems is to be applied when designing dry pipe systems.

Dry Pipe System Water Delivery
When using the Series LFII Residential Sprinklers (TY2234) in dry pipe sprinkler systems, the time for water delivery must not exceed 15 seconds for the most remote operating sprinkler.

Obstruction to Water Distribution
Sprinklers are to be located in accordance with the obstruction rules of NFPA 13D, 13R, and 13 as applicable for residential sprinklers as well as with the obstruction criteria described within the Technical Data Sheet TFP490.

Operational Sensitivity
Sprinklers are to be installed with a deflector-to-ceiling distance of 1-1/4 to 4 inches.

Sprinkler Spacing
The minimum spacing between sprinklers is 8 feet (2,4 m). The maximum spacing between sprinklers cannot exceed the length of the coverage area (Table A or B) being hydraulically calculated (e.g., maximum 12 feet for a 12 ft. x 12 ft. coverage area, or 20 feet for a 20 ft. x 20 ft. coverage area).

Maximum Coverage Area [1] Ft. x Ft. (m x m)	WET PIPE SYSTEM Minimum Flow and Residual Pressure [2][3]				Deflector to Ceiling	Installation Type	Minimum Spacing Ft. (m)
	Ordinary Temperature Rating 155°F (68°C)		Intermediate Temperature Rating 175°F (79°C)				
	Flow gpm (l/min)	Pressure psi (bar)	Flow gpm (l/min)	Pressure psi (bar)			
12 x 12 (3,7 x 3,7)	13 (49,2)	7.0 (0,48)	13 (49,2)	7.0 (0,48)	Smooth Ceilings 1-1/4 to 4 inches Beamed Ceilings per NFPA 13D or 13R 1-1/4 to 1-3/4 inches below bottom of beam.	Recessed using Style 20 Escutcheon or non-recessed per NFPA 13D, 13R, or 13	8 (2,4)
14 x 14 (4,3 x 4,3)	13 (49,2)	7.0 (0,48)	13 (49,2)	7.0 (0,48)			
16 x 16 (4,9 x 4,9)	13 (49,2)	7.0 (0,48)	13 (49,2)	7.0 (0,48)			
18 x 18 (5,5 x 5,5)	17 (64,3)	12.0 (0,83)	17 (64,3)	12.0 (0,83)			
20 x 20 (6,1 x 6,1)	20 (75,7)	16.7 (1,15)	20 (75,7)	16.7 (1,15)			

Notes:
1. For coverage area dimensions less than or between those indicated, use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.
2. Requirement is based on minimum flow in gpm (lpm) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design under the Design Criteria section.
3. For NFPA 13 residential applications, the greater of 0.1 gpm/ft.^{2} over the design area or the flow in accordance with the criteria in this table must be used.

TABLE A
WET PIPE SYSTEM
SERIES LFII RESIDENTIAL 4.9K PENDENT AND RECESSED PENDENT SPRINKLERS (TY2234)
NFPA 13D, 13R, AND 13 HYDRAULIC DESIGN CRITERIA

Maximum Coverage Area [1] Ft. x Ft. (m x m)	DRY PIPE SYSTEM Minimum Flow and Residual Pressure [2][3]				Deflector to Ceiling	Installation Type	Minimum Spacing Ft. (m)
	Ordinary Temperature Rating 155°F (68°C)		Intermediate Temperature Rating 175°F (79°C)				
	Flow gpm (l/min)	Pressure psi (bar)	Flow gpm (l/min)	Pressure psi (bar)			
12 x 12 (3,7 x 3,7)	13 (49,2)	7.0 (0,48)	13 (49,2)	7.0 (0,48)	Smooth Ceilings 1-1/4 to 4 inches Beamed Ceilings per NFPA 13D or 13R 1-1/4 to 1-3/4 inches below bottom of beam.	Recessed using Style 20 Escutcheon or non-recessed per NFPA 13D, 13R, or 13	8 (2,4)
14 x 14 (4,3 x 4,3)	14 (53,0)	8.2 (0,57)	14 (53,0)	8.2 (0,57)			
16 x 16 (4,9 x 4,9)	15 (56,8)	9.4 (0,65)	15 (56,8)	9.4 (0,65)			
18 x 18 (5,5 x 5,5)	18 (68,1)	13.5 (0,93)	18 (68,1)	13.5 (0,93)			
20 x 20 (6,1 x 6,1)	21 (79,5)	18.4 (1,27)	21 (79,5)	18.4 (1,27)			

Notes:
1. For coverage area dimensions less than or between those indicated, use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.
2. Requirement is based on minimum flow in gpm (lpm) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design under the Design Criteria section.
3. For NFPA 13 residential applications, the greater of 0.1 gpm/ft.^{2} over the design area or the flow in accordance with the criteria in this table must be used.

TABLE B
DRY PIPE SYSTEM
SERIES LFII RESIDENTIAL 4.9K PENDENT AND RECESSED PENDENT SPRINKLERS (TY2234)
NFPA 13D, 13R, AND 13 HYDRAULIC DESIGN CRITERIA

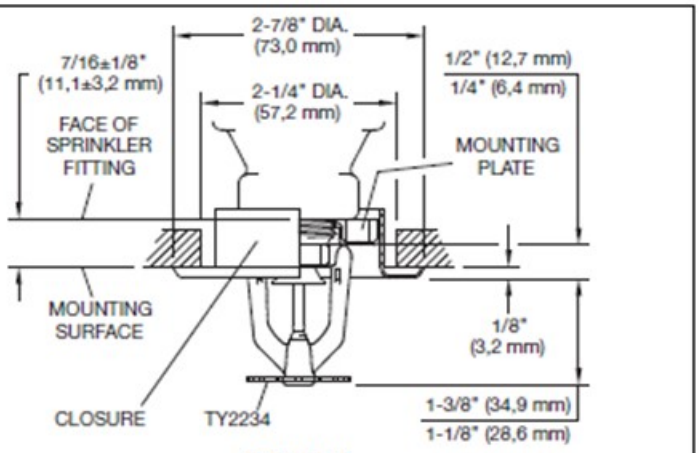


FIGURE 2
STYLE 20 RECESSED ESCUTCHEON FOR USE WITH THE RAPID RESPONSE SERIES LFII RESIDENTIAL PENDENT SPRINKLER

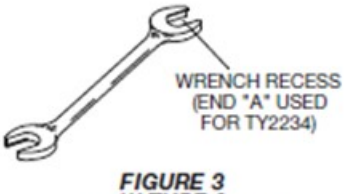


FIGURE 3
W-TYPE 6
SPRINKLER WRENCH

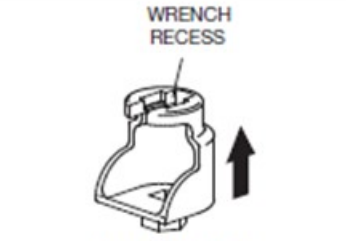


FIGURE 4
W-TYPE 7 RECESSED
SPRINKLER WRENCH

Installation

TYCO RAPID RESPONSE Series LFII Residential 4.9K Pendent and Recessed Pendent Sprinklers must be installed in accordance with this section.

General Instructions
Do not install any bulb type sprinkler if the bulb is cracked or there is a loss of liquid from the bulb. With the sprinkler held horizontally, a small air bubble should be present. The diameter of the air bubble is approximately 1/16 inch (1,6 mm).

A leak-tight 1/2 inch NPT sprinkler joint should be obtained by applying a minimum-to-maximum torque of 7 to 14 ft.-lbs. (9,5 to 19,0 Nm). Higher levels of torque can distort the sprinkler Inlet with consequent leakage or impairment of the sprinkler.

Do not attempt to compensate for insufficient adjustment in an Escutcheon Plate by under- or over- tightening the sprinkler. Re-adjust the position of the sprinkler fitting to suit.

Pendent Sprinklers
The Series LFII Residential Pendent Sprinklers must be installed in accordance with the following instructions:

Step 1. Install pendent sprinklers in the pendent position with the deflector parallel to the ceiling.

Step 2. With pipe thread sealant applied to the pipe threads, hand-tighten the sprinkler into the sprinkler fitting.

Step 3. Tighten the sprinkler into the sprinkler fitting using only the W-Type 6 Sprinkler Wrench (Figure 3). With reference to Figure 1, apply the W-Type 6 Sprinkler Wrench to the wrench flats.

Recessed Pendent Sprinklers
The Series LFII Residential Recessed Pendent Sprinklers must be installed in accordance with the following instructions:

Step A. Install recessed pendent sprinklers in the pendent position with the deflector parallel to the ceiling.

Step B. After installing the Style 20 Mounting Plate over the sprinkler threads and with pipe thread sealant applied to the pipe threads, hand-tighten the sprinkler into the sprinkler fitting.

Step C. Tighten the sprinkler into the sprinkler fitting using only the W-Type 7 Recessed Sprinkler Wrench (Figure 4). With reference to Figure 1, apply the W-Type 7 Recessed Sprinkler Wrench to the sprinkler wrench flats.

Step D. After the ceiling has been installed or the finish coat has been applied, slide on the Style 20 Closure over the Series LFII Residential Sprinkler and push the Closure over the Mounting Plate until its flange comes in contact with the ceiling.

Care and Maintenance

TYCO RAPID RESPONSE Series LFII Residential 4.9K Pendent and Recessed Pendent Sprinklers must be maintained and serviced in accordance with this section:

Before closing a fire protection system main control valve for maintenance work on the fire protection system that it controls, permission to shut down the affected fire protection system must be obtained from the proper authorities and notify all personnel who may be affected by this action.

Absence of the outer piece of an escutcheon, which is used to cover a clearance hole, can delay sprinkler operation in a fire situation.

The owner must assure that the sprinklers are not used for hanging any objects and that the sprinklers are only cleaned by means of gently dusting with a feather duster; otherwise, non-operation in the event of a fire or inadvertent operation may result.

Sprinklers which are found to be leaking or exhibiting visible signs of corrosion must be replaced.

Automatic sprinklers must never be painted, plated, coated, or otherwise altered after leaving the factory. Modified sprinklers must be replaced. Sprinklers that have been exposed to corrosive products of combustion, but have not operated, should be replaced if they cannot be completely cleaned by wiping the sprinkler with a cloth or by brushing it with a soft bristle brush.

Care must be exercised to avoid damage to the sprinklers before, during, and after installation. Sprinklers damaged by dropping, striking, wrench twist/slippage, or the like, must be replaced. Also, replace any sprinkler that has a cracked bulb or that has lost liquid from its bulb (Ref. Installation section).

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable standards of the National Fire Protection Association (e.g., NFPA 25), in addition to the standards of any authorities having jurisdiction. Contact the installing contractor or product manufacturer with any questions.

Automatic sprinkler systems are recommended to be inspected, tested, and maintained by a qualified Inspection Service in accordance with local requirements and/or national codes.

Limited Warranty

For warranty terms and conditions, visit www.tyco-fire.com.

Ordering Procedure

Contact your local distributor for availability. When placing an order, indicate the full product name and part number (P/N).

Sprinkler Assemblies
Specify: Series LFII 4.9K Residential Pendent Sprinkler (TY2234), (specify temperature rating), with (specify) finish, P/N (specify):

155°F (68°C)

Natural Brass	51-201-1-155
Pure White (RAL 9010)*	51-201-3-155
Signal White (RAL 9003)	51-201-4-155
Chrome Plated	51-201-9-155

175°F (79°C)

Natural Brass	51-201-1-175
Pure White (RAL 9010)*	51-201-3-175
Signal White (RAL 9003)	51-201-4-175
Chrome Plated	51-201-9-175

* Eastern Hemisphere sales only

Recessed Escutcheon
Specify: Style 20 Recessed Escutcheon with (specify*) finish, P/N (specify*)

* Refer to Technical Data Sheet TFP770.

Sprinkler Wrenches
Specify: W-Type 6 Sprinkler Wrench, P/N 56-000-6-387

Specify: W-Type 7 Sprinkler Wrench, P/N 56-850-4-001

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RAPID RESPONSE Series LFII Residential Sprinklers 4.4 K-factor Horizontal Sidewall Wet Pipe Systems

General Description

The TYCO RAPID RESPONSE Series LFII Residential Horizontal Sidewall Sprinklers (TY2334) are decorative, fast response, frangible bulb sprinklers designed for use in residential occupancies such as homes, apartments, dormitories, and hotels. When aesthetics and optimized flow characteristics are the major consideration, the Series LFII Residential Sprinklers (TY2334) should be the first choice.

The Series LFII Residential Sprinklers are intended for use in the following scenarios:

- wet pipe residential sprinkler systems for one-and two-family dwellings and mobile homes per NFPA 13D
- wet pipe residential sprinkler systems for residential occupancies up to and including four stories in height per NFPA 13R
- wet pipe sprinkler systems for the residential portions of any occupancy per NFPA 13

The recessed version of the Series LFII Residential Sprinklers is intended for use in areas with finished walls. It employs a two-piece Style 20 Recessed Escutcheon. The Recessed Escutcheon provides 1/4 inch (6,4 mm) of recessed adjustment or up to 1/2 inch (12,7 mm) of total adjustment from the flush mounting surface position. The adjustment provided by the Recessed Escutcheon reduces the accuracy to which the pipe nipples to the sprinklers must be cut.

The Series LFII Residential Sprinklers has been designed with heat sensitivity and water distribution characteristics proven to help in the control of residential fires and to improve the chance for occupants to escape or be evacuated.

IMPORTANT

Always refer to Technical Data Sheet TFP700 for the "INSTALLER WARNING" that provides cautions with respect to handling and installation of sprinkler systems and components. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in a fire situation or cause it to operate prematurely.

NOTICE

The Series LFII Residential Horizontal Sidewall Sprinklers (TY2334) described herein must be installed and maintained in compliance with this document and with the applicable standards of the National Fire Protection Association, in addition to the standards of any authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. The installing contractor or sprinkler manufacturer should be contacted with any questions.

Sprinkler Identification Number (SIN)

TY2334

Technical Data

Approvals
UL and C-UL Listed

Certified to all requirements of NSF/ANSI 61

(Refer to the Design Criteria section for details on these approvals.)

Maximum Working Pressure
Maximum 175 psi (12,1 bar)

Discharge Coefficient
K= 4.4 GPM/psi$^{1/2}$ (63,4 LPM/bar$^{1/2}$)





Temperature Rating
155°F (68°C) or 175°F (79°C)

Finishes
Natural Brass, Signal White, or Chrome Plated

Physical Characteristics

Frame	Brass
Button	Bronze
Sealing Assembly	Beryllium Nickel w/ TEFLON
Bulb	3 mm Glass
Compression Screw	Bronze
Deflector	Copper

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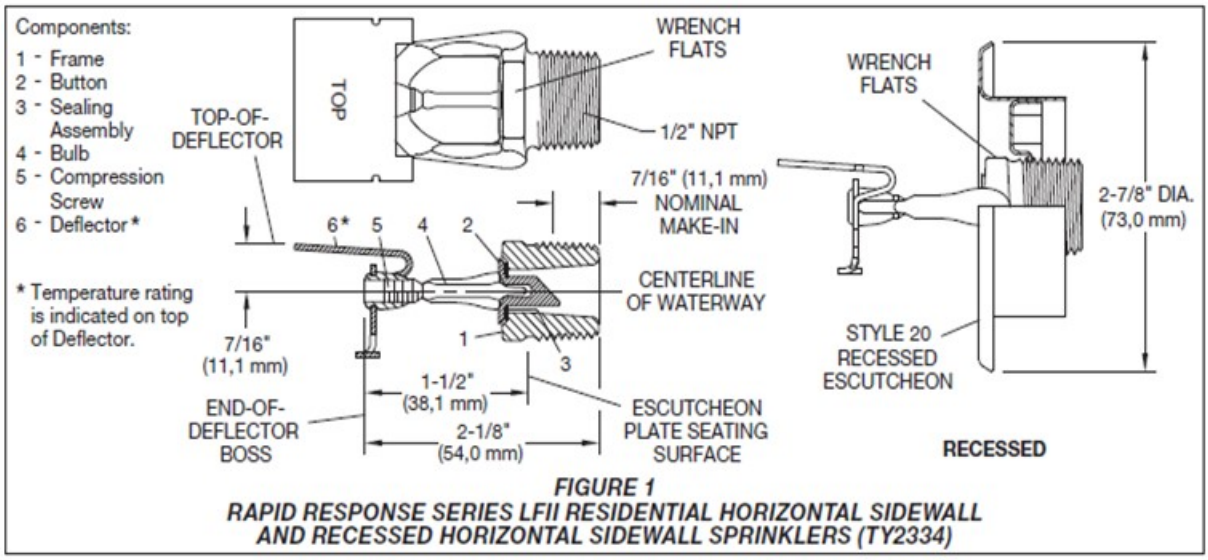


FIGURE 1
RAPID RESPONSE SERIES LFII RESIDENTIAL HORIZONTAL SIDEWALL AND RECESSED HORIZONTAL SIDEWALL SPRINKLERS (TY2334)

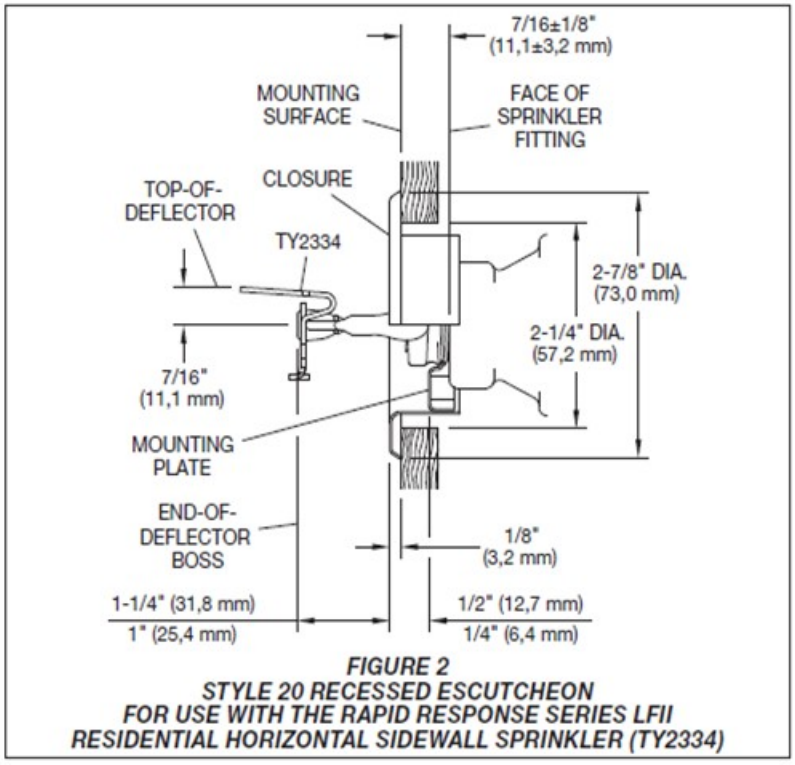


FIGURE 2
STYLE 20 RECESSED ESCUTCHEON FOR USE WITH THE RAPID RESPONSE SERIES LFII RESIDENTIAL HORIZONTAL SIDEWALL SPRINKLER (TY2334)

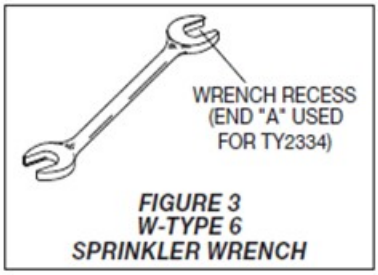


FIGURE 3
W-TYPE 6
SPRINKLER WRENCH

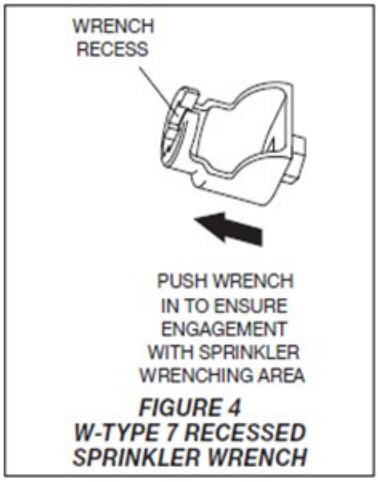


FIGURE 4
W-TYPE 7 RECESSED
SPRINKLER WRENCH

Operation

The glass bulb contains a fluid that expands when exposed to heat. When the rated temperature is reached, the fluid expands sufficiently to shatter the glass bulb allowing the sprinkler to activate and flow water.

Design Criteria

The TYCO RAPID RESPONSE Series LFII (TY2334) Residential Horizontal Sidewall Sprinklers are UL and C-UL Listed for installation in accordance with this section.

Residential Sprinkler Design Guide
When conditions exist that are outside the scope of the provided criteria, refer to the Residential Sprinkler Design Guide TFP490 for the manufacturer's recommendations that may be acceptable to the local authority having jurisdiction.

System Type
Only wet pipe systems may be utilized.

Ceiling Type
Smooth flat horizontal, or beamed, or sloped, in accordance with the 2013 Edition of NFPA 13D, 13R, or 13 as applicable.

Hydraulic Design (NFPA 13D and 13R)
For systems designed to NFPA 13D or NFPA 13R, the minimum required sprinkler flow rate are given in Table A as a function of temperature rating and the maximum allowable coverage areas. The sprinkler flow rate is the minimum required discharge from each of the total number of "design sprinklers" as specified in NFPA 13D or NFPA 13R.

Hydraulic Design (NFPA 13)
For systems designed to NFPA 13, the number of design sprinklers is to be the four most hydraulically demanding sprinklers. The minimum required discharge from each of the four sprinklers is to be the greater of the following:

- The flow rates given in Table A as a function of temperature rating and the maximum allowable coverage area.
- A minimum discharge of 0.1 gpm/ft^2 over the "design area" comprised of the four most hydraulically demanding sprinklers for the actual coverage areas being protected by the four sprinklers.

Obstruction to Water Distribution
Sprinklers are to be located in accordance with the obstruction rules of NFPA 13D, 13R, and 13 as applicable for residential sprinklers as well as with the obstruction criteria described within the Technical Data Sheet TFP490.

Operational Sensitivity
The sprinklers are to be installed with an end of defector-boss to wall distance of 1-1/8 to 6 inches.

In addition the top-of-deflector-to-ceiling distance is to be within the range (Ref. Table A) being hydraulically calculated.

Sprinkler Spacing
The minimum spacing between sprinklers is 8 feet (2,4 m). The maximum spacing between sprinklers cannot exceed the width of the coverage area (Ref. Table A) being hydraulically calculated (e.g., maximum 12 feet for a 12 ft. x 12 ft. coverage area, or 16 feet for a 16 ft. x 20 ft. coverage area).

Installation

The TYCO RAPID RESPONSE Series LFII (TY2334) Residential Horizontal Sidewall Sprinklers must be installed in accordance with this section.

General Instructions
Do not install any bulb-type sprinkler if the bulb is cracked or there is a loss of liquid from the bulb. With the sprinkler held horizontally, a small air bubble should be present. The diameter of the air bubble is approximately 1/16 inch (1,6 mm).

A leak-tight 1/2 inch NPT sprinkler joint should be obtained by applying a minimum to maximum torque of 7 to 14 ft.-lbs. (9,5 to 19,0 Nm). Higher levels of torque can distort the sprinkler inlet with consequent leakage or impairment of the sprinkler.

Do not attempt to compensate for insufficient adjustment in the sprinkler by under- or over-tightening the sprinkler. Re-adjust the position of the sprinkler fitting to suit.

Series LFII Residential Horizontal Sidewall Sprinklers
The Series LFII Horizontal Sidewall Sprinklers must be installed in accordance with the following instructions.

Step 1. Horizontal sidewall sprinklers are to be installed in the horizontal position with their centerline of waterway perpendicular to the back wall and parallel to the ceiling. The word "TOP" on the Deflector is to face towards the ceiling with the front edge of the Deflector parallel to the ceiling.

Step 2. With pipe thread sealant applied to the pipe threads, hand tighten the sprinkler into the sprinkler fitting.

Step 3. Tighten the sprinkler into the sprinkler fitting using only the W-Type 6 Sprinkler Wrench (Ref. Figure 3). With reference to Figure 1, the W-Type 6 Sprinkler Wrench is to be applied to the wrench flats.

Series LFII Residential Recessed Horizontal Sidewall Sprinklers
The Series LFII Recessed Horizontal Sidewall Sprinklers must be installed in accordance with the following instructions.

Step A. Recessed horizontal sidewall sprinklers are to be installed in the horizontal position with their centerline of waterway perpendicular to the back wall and parallel to the ceiling. The word "TOP" on the Deflector is to face towards the ceiling.

Step B. After installing the Style 20 Mounting Plate over the sprinkler threads and with pipe thread sealant applied to the pipe threads, hand tighten the sprinkler into the sprinkler fitting.

Step C. Tighten the sprinkler into the sprinkler fitting using only the W-Type 7 Recessed Sprinkler Wrench (Ref. Figure 4). With reference to Figure 1, the W-Type 7 Recessed Sprinkler Wrench is to be applied to the sprinkler wrench flats.

Step D. After the wall has been installed or the finish coat has been applied, slide on the Style 20 Closure over the Series LFII Sprinkler and push the Closure over the Mounting Plate until its flange comes in contact with the wall.

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Max. Coverage Area [a] Width x Length [d] Ft. x Ft. (m x m)	Max. Spacing Ft. (m)	WET PIPE SYSTEM Minimum Flow and Residual Pressure[b, c]						
		Ordinary Temp. Rating 155°F (68°C)		Intermediate Temp. Rating 175°F (79°C)		Deflector to Ceiling	Installation Type	Minimum Spacing Ft. (m)
		Flow GPM (L/min)	Pressure PSI (bar)	Flow GPM (L/min)	Pressure PSI (bar)			
12 x 12 (3,7 x 3,7)	12 (3,7)	13 (49,2)	8.7 (0,60)	13 (49,2)	8.7 (0,60)	4 to 6 inches	Recessed using Style 20 Escutcheon or non-recessed per NFPA 13D, 13R, or 13	8 (2,4)
14 x 14 (4,3 x 4,3)	14 (4,3)	14 (53,0)	10.1 (0,70)	14 (53,0)	10.1 (0,70)			
16 x 16 (4,9 x 4,9)	16 (4,9)	16 (60,6)	13.2 (0,91)	16 (60,6)	13.2 (0,91)			
16 x 18 (4,9 x 5,5)	16 (4,9)	19 (71,9)	18.6 (1,28)	19 (71,9)	18.6 (1,28)			
16 x 20 (4,9 x 6,1)	16 (4,9)	23 (87,1)	27.3 (1,88)	23 (87,1)	27.3 (1,88)			
18 x 18 (5,5 x 5,5)	18 (5,5)	23 (87,1)	27.3 (1,88)	23 (87,1)	27.3 (1,88)			
18 x 20 (5,5 x 6,1)	18 (5,5)	26 (98,4)	34.9 (2,41)	26 (98,4)	34.9 (2,41)			
12 x 12 (3,7 x 3,7)	12 (3,7)	13 (49,2)	8.7 (0,60)	13 (49,2)	8.7 (0,60)	6 to 12 inches		
14 x 14 (4,3 x 4,3)	14 (4,3)	14 (53,0)	10.1 (0,70)	14 (53,0)	10.1 (0,70)			
16 x 16 (4,9 x 4,9)	16 (4,9)	17 (64,3)	14.9 (1,03)	17 (64,3)	14.9 (1,03)			
16 x 18 (4,9 x 5,5)	16 (4,9)	20 (75,7)	20.7 (1,43)	20 (75,7)	20.7 (1,43)			
16 x 20 (4,9 x 6,1)	16 (4,9)	23 (87,1)	27.3 (1,88)	23 (87,1)	27.3 (1,88)			
18 x 18 (5,5 x 5,5)	18 (5,5)	23 (87,1)	27.3 (1,88)	23 (87,1)	27.3 (1,88)			
18 x 20 (5,5 x 6,1)	18 (5,5)	26 (98,4)	34.9 (2,41)	26 (98,4)	34.9 (2,41)			

a. For coverage area dimensions less than or between those indicated, use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.
b. Requirement is based on minimum flow in GPM (LPM) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design under the Design Criteria section.
c. For NFPA 13 residential applications, the greater of 0.1 gpm/ft² over the design area or the flow in accordance with the criteria in this table must be used.
d. The Width x Length dimension refers to the Width (backwall where the sprinkler is located) times the Length (horizontal throw of sprinkler).

TABLE A
WET PIPE SYSTEMS
SERIES LFII (TY2334) RESIDENTIAL HORIZONTAL SIDEWALL
AND RECESSED HORIZONTAL SIDEWALL SPRINKLERS
NFPA 13D, 13R AND 13 WET PIPE HYDRAULIC DESIGN CRITERIA

Care and Maintenance

The TYCO RAPID RESPONSE Series LFII (TY2334) Residential Horizontal Sidewall Sprinklers must be maintained and serviced in accordance with this section.

Before closing a fire protection system main control valve for maintenance work on the fire protection system which it controls, permission to shut down the affected fire protection system must be obtained from the proper authorities and all personnel who may be affected by this action must be notified.

Absence of an Escutcheon Plate may delay the sprinkler operation in a fire situation.

The owner must assure that the sprinklers are not used for hanging any objects and that the sprinklers are only cleaned by means of gently dusting with a feather duster; otherwise, non-operation in the event of a fire or inadvertent operation may result.

Sprinklers which are found to be leaking or exhibiting visible signs of corrosion must be replaced.

Automatic sprinklers must never be painted, plated, coated, or otherwise altered after leaving the factory. Modified sprinklers must be replaced. Sprinklers that have been exposed to corrosive products of combustion, but have not operated, should be replaced if they cannot be completely cleaned by wiping the sprinkler with a cloth or by brushing it with a soft bristle brush.

Care must be exercised to avoid damage to the sprinklers - before, during, and after installation. Sprinklers damaged by dropping, striking, wrench twist/slippage, or the like, must be replaced. Also, replace any sprinkler that has a cracked bulb or that has lost liquid from its bulb. (Ref. Installation Section).

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable standards of the National Fire Protection Association (e.g., NFPA 25), in addition to the standards of any other authorities having jurisdiction. The installing contractor or sprinkler manufacturer should be contacted relative to any questions.

Automatic sprinkler systems are recommended to be inspected, tested, and maintained by a qualified Inspection Service in accordance with local requirements and/or national codes.

Limited Warranty

For warranty terms and conditions, visit www.tyco-fire.com.

Ordering Procedure

Contact your local distributor for availability. When placing an order, indicate the full product name and Part Number (P/N):

Sprinkler Assembly
Specify: Series LFII (TY2334), K=4.4, Residential Horizontal Sidewall Sprinkler, (specify) temperature rating, (specify) finish, P/N (specify):

155°F (68°C)

Natural Brass	51-215-1-155
Signal White (RAL9003)	51-215-4-155
Chrome Plated	51-215-9-155

175°F (79°C)

Natural Brass	51-215-1-175
Signal White (RAL9003)	51-215-4-175
Chrome Plated	51-215-9-175

Recessed Escutcheon
Specify: Style 20 Recessed Escutcheon with (specify*) finish, P/N (specify*).

* Refer to Technical Data Sheet TFP770.

Sprinkler Wrench
Specify: W-Type 6 Sprinkler Wrench, P/N 56-000-6-387

Specify: W-Type 7 Sprinkler Wrench, P/N 56-850-4-001

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Series TY-B – 5.6 K-factor Horizontal and Vertical Sidewall Sprinklers Standard Response, Standard Coverage

General Description

The TYCO Series TY-B, 5.6 K-factor, Horizontal and Vertical Sidewall Sprinklers described in this technical data sheet are standard response, standard coverage decorative 5 mm glass bulb type spray sprinklers designed for use in light and ordinary hazard, commercial occupancies such as banks, hotels, and shopping malls.

They are designed for installation along a wall or the side of a beam and just beneath a smooth ceiling. Sidewall sprinklers are commonly used instead of pendent or upright sprinklers due to aesthetics or building construction considerations, where piping across the ceiling is not desirable.

The recessed version of the Series TY-B Horizontal Sidewall Sprinkler is intended for use in areas with a finished wall. It uses a two-piece Style 10 Recessed Escutcheon. The Recessed Escutcheon provides 1/2 inch (12,7 mm) of recessed adjustment or up to 3/4 inch (19,1 mm) of total adjustment from the flush sidewall position. The adjustment provided by the Recessed Escutcheon reduces the accuracy to which the fixed pipe nipples to the sprinklers must be cut.

Corrosion-resistant coatings, where applicable, are utilized to extend the life of copper alloy sprinklers beyond that which would otherwise be obtained when exposed to corrosive atmospheres. Although corrosion resistant coated sprinklers have passed the standard corrosion tests of the applicable approval agencies, the testing is not representative of all possible corrosive atmospheres. Consequently, it is recommended that the end user be consulted with respect to the suitability of these coatings for any given corrosive environment. The effects of ambient temperature, concentration of chemicals, and gas/chemical velocity, should be considered, as a minimum, along with the corrosive nature of the chemical to which the sprinklers will be exposed.

IMPORTANT

Always refer to Technical Data Sheet TFP700 for the "INSTALLER WARNING" that provides cautions with respect to handling and installation of sprinkler systems and components. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in a fire situation or cause it to operate prematurely.

NOTICE

The Series TY-B Sprinklers described herein must be installed and maintained in compliance with this document, as well as with the applicable standards of the National Fire Protection Association, in addition to the standards of any other authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. Contact the installing contractor or product manufacturer with any questions.

Sprinkler Identification Numbers

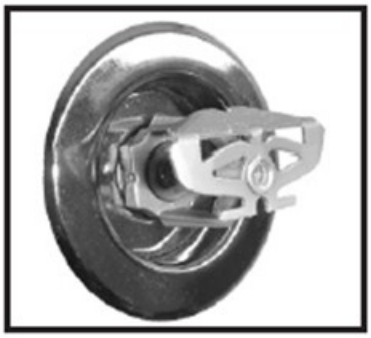
TY3351 – Horizontal Sidewall
TY3451 – Vertical Sidewall

Technical Data

Approvals
UL and C-UL Listed
FM Approved
LPCB Certified
NYC Approved

(Refer to Table A for complete approval information, including corrosion-resistant status.)

Maximum Working Pressure
Refer to Table B





Discharge Coefficient
K=5.6 gpm/psi$^{1/2}$ (80,6 lpm/bar$^{1/2}$)

Temperature Ratings
Refer to Table A

Finishes
Sprinkler: Refer to Table C

Recessed Escutcheon: Signal or Pure White, Jet Black, Chrome Plated, or Natural Brass

Physical Characteristics

Frame	Bronze
Button	Brass/Copper
Sealing Assembly	Beryllium Nickel w/ TEFLON
Bulb	Glass
Compression Screw	Bronze
HSW Deflector	Bronze
VSW Deflector	Copper

Operation

The glass bulb contains a fluid which expands when exposed to heat. When the rated temperature is reached, the fluid expands sufficiently to shatter the glass bulb, allowing the sprinkler to activate and water to flow.

Design Criteria

The TYCO Series TY-B, 5.6 K-factor, Horizontal and Vertical Sidewall Sprinklers are intended for fire protection systems designed in accordance with the standard installation rules recognized by the applicable Listing or Approval agency (for example, UL Listing is based on the requirements of NFPA 13, and FM Approval is based on the requirements of the FM Loss Prevention Data Sheets). Only the Style 10 Recessed Escutcheon, as applicable, is to be used for recessed horizontal installations.

Installation

The TYCO Series TY-B, 5.6 K-factor, Horizontal and Vertical Sidewall Sprinklers must be installed in accordance with this section.

General Instructions
Do not install any bulb type sprinkler if the bulb is cracked or there is a loss of liquid from the bulb. With the sprinkler held horizontally, a small air bubble should be present. The diameter of the air bubble is approximately 1/16 inch (1,6 mm) for the 135°F (57°C) to 3/32 inch (2,4 mm) for the 360°F (182°C) temperature ratings.

A leak-tight 1/2 inch NPT sprinkler joint should be obtained by applying a minimum-to-maximum torque of 7 to 14 ft.-lbs. (9,5 to 19,0 Nm). Higher levels of torque may distort the sprinkler inlet and cause leakage or impairment of the sprinkler.

Do not attempt to make-up for insufficient adjustment in the escutcheon plate by under- or over-tightening the sprinkler. Readjust the position of the sprinkler fitting to suit.

Horizontal Sidewall Sprinkler Installation
The TYCO Series TY-B Recessed Horizontal Sidewall Sprinklers must be installed in accordance with the following instructions.

Install recessed horizontal sidewall sprinklers in the horizontal position with the centerline of waterway perpendicular to the back wall and parallel to the ceiling. The word "TOP" on the Deflector is to face towards the ceiling.

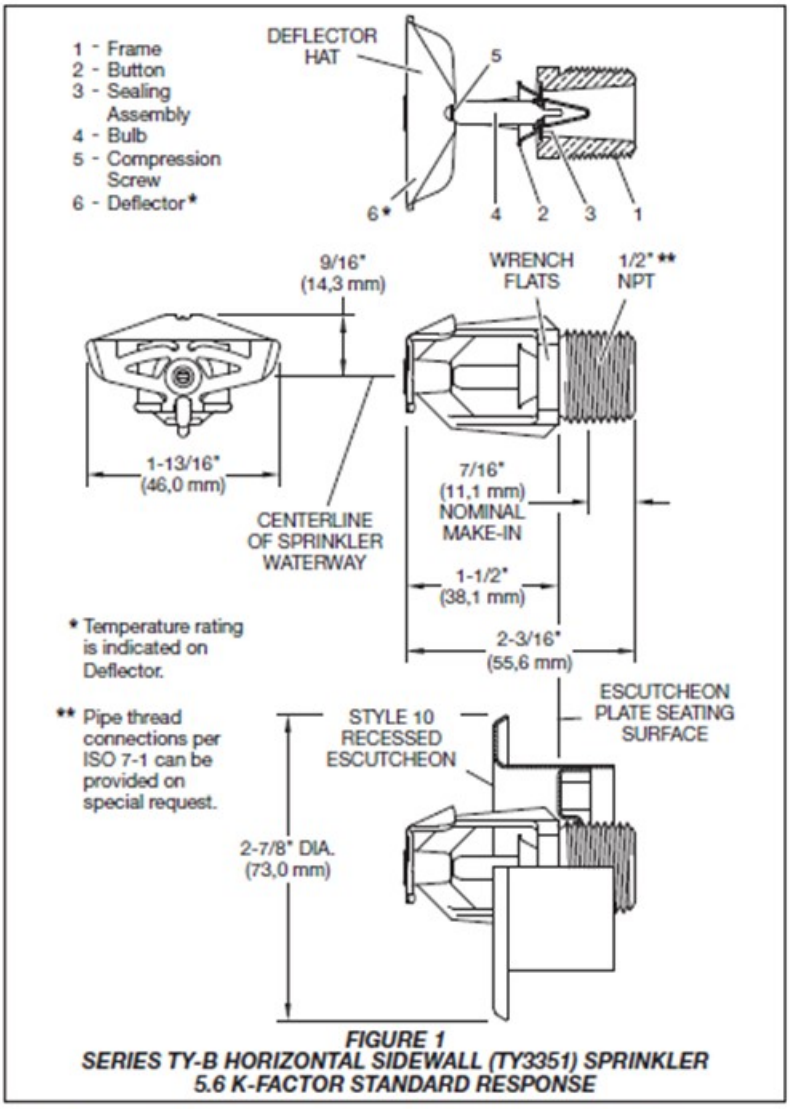


FIGURE 1
SERIES TY-B HORIZONTAL SIDEWALL (TY3351) SPRINKLER
5.6 K-FACTOR STANDARD RESPONSE

Step A. After installing the Style 10 Mounting Plate over the sprinkler threads, hand-tighten the sprinkler into the sprinkler fitting.

Step B. Tighten the sprinkler into the sprinkler fitting using only the W-Type 7 Recessed Sprinkler Wrench (Ref. Figure 5). Apply the W-Type 7 Recessed Sprinkler Wrench to the sprinkler wrench flats (Ref. Figure 1).

Step C. After the ceiling is installed or the finish coat is applied, slide on the Style 10 Closure over the Series TY-B Sprinkler and push the Closure over the Mounting Plate until its flange comes in contact with the ceiling.

Vertical Sidewall Sprinkler Installation
The Series TY-B Vertical Sidewall Sprinklers must be installed in accordance with the following instructions.

Install vertical sidewall sprinklers in the pendent or upright position with the arrow on the Deflector pointing away from the wall.

Step 1. With pipe thread sealant applied to the pipe threads, hand-tighten the sprinkler into the sprinkler fitting.

Step 2. Tighten the sprinkler into the sprinkler fitting using only the W-Type 6 Sprinkler Wrench (Ref. Figure 4). For wax-coated sprinklers, use an 8 or 10 inch adjustable Crescent wrench. Apply the W-Type 6 Sprinkler Wrench or the Crescent wrench, as applicable, to the wrench flats (Ref. Figure 2).

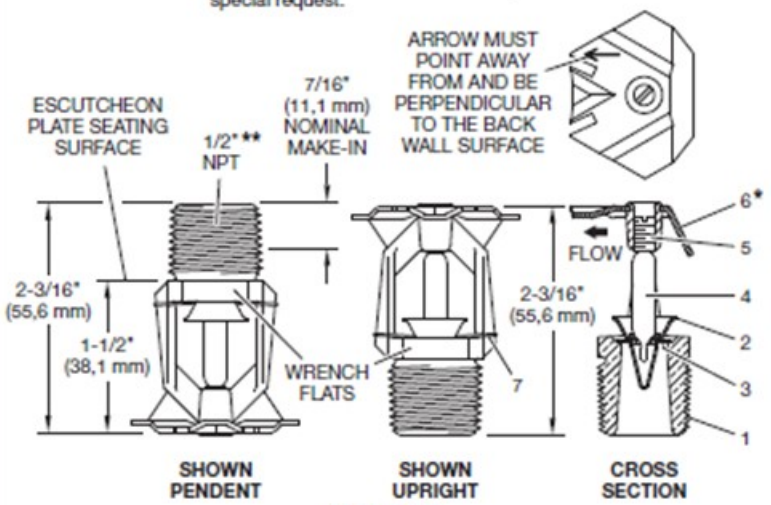


FIGURE 2
SERIES TY-B VERTICAL SIDEWALL (TY3451) SPRINKLER
5.6 K-FACTOR, STANDARD RESPONSE

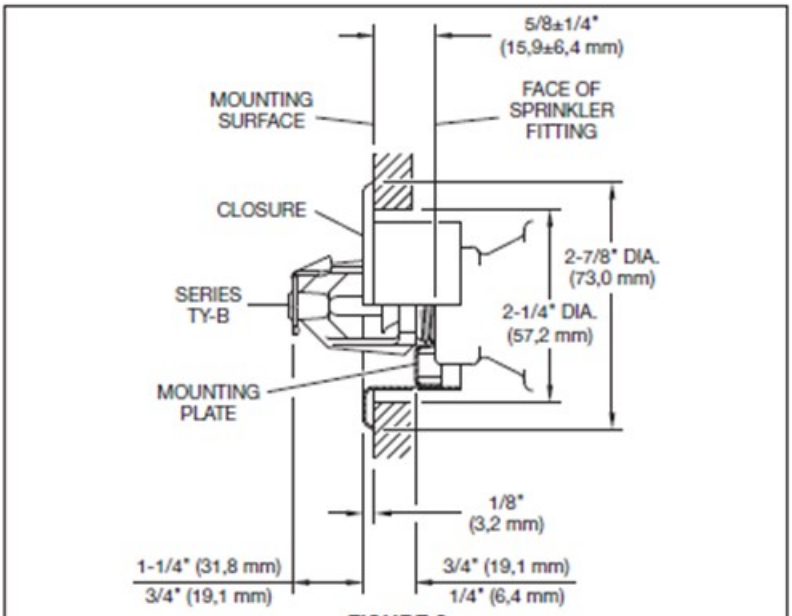


FIGURE 3
SERIES TY-B RECESSED PENDENT SPRINKLER ASSEMBLY
WITH TWO-PIECE 3/4 INCH TOTAL ADJUSTMENT
STYLE 10 RECESSED ESCUTCHEON, 5.6 K-FACTOR, 1/2 INCH NPT

When installing wax-coated sprinklers with the adjustable Crescent wrench, exercise care to prevent damage to the wax coating on the sprinkler wrench flats or frame arms and, consequently, exposure of bare metal to the corrosive environment. Open the jaws of the wrench sufficiently wide to pass over the wrench flats without damaging the wax coating. Before wrench-tightening the sprinkler, adjust the jaws of the wrench to contact only the sprinkler wrench flats. After wrench tightening the sprinkler, loosen the wrench jaws before removing the wrench.



FIGURE 4
W-TYPE 6
SPRINKLER WRENCH

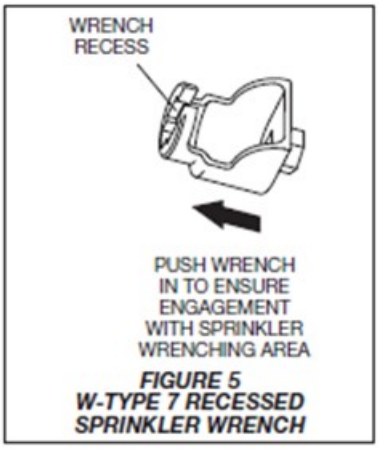


FIGURE 5
W-TYPE 7 RECESSED
SPRINKLER WRENCH

After installation, inspect the sprinkler wrench flats and frame arms and retouch (repair) the wax coating whenever the coating has been damaged and bare metal is exposed. Retouch the wax coating on the wrench flats by gently applying a heated 1/8 inch diameter steel rod to the damaged areas of wax to smooth it back over areas where bare metal is exposed.

NOTICE

Only retouching of the wax coating applied to the wrench flats and frame arms is permitted, and the retouching is to be performed only at the time of the initial sprinkler installation.

The steel rod should be heated only to the point at which it can begin to melt the wax, and appropriate precautions need to be taken when handling the heated rod in order to prevent the installer from being burned.

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K	SPRINKLER TYPE	TEMPERATURE RATING	BULB LIQUID COLOR	SPRINKLER FINISH (10)					
				NATURAL BRASS	CHROME PLATED	POLYESTER***	LEAD COATED	WAX COATED	WAX-OVER-LEAD COATED
5.6 1/2" NPT	HORIZONTAL SIDEWALL (TY3351) Figure 1	135°F (57°C)	Orange	1, 2, 3, 4, 9		1, 2, 3, 9	1, 2, 3, 9	1, 2, 3, 9	
		155°F (68°C)	Red						
		175°F (79°C)	Yellow						
		200°F (93°C)	Green						
		286°F (141°C)	Blue					1**, 2**, 3**, 9**	
		360°F (182°C)	Mauve	1, 2, 4, 9		1, 2, 9		N/A	
	RECESSED HORIZONTAL SIDEWALL (TY3351)* Figure 3	135°F (57°C)	Orange	1, 2, 3, 9			N/A		
		155°F (68°C)	Red						
		175°F (79°C)	Yellow						
		200°F (93°C)	Green						
5.6 1/2" NPT	VERTICAL SIDEWALL (TY3451) PENDENT or UPRIGHT Figure 2	135°F (57°C)	Orange	4, 5, 6, 7, 8, 9			5, 6, 7, 9	5, 6, 7, 9	
		155°F (68°C)	Red						
		175°F (79°C)	Yellow						
		200°F (93°C)	Green						
		286°F (141°C)	Blue					5**, 6**, 7**, 9**	
		360°F (182°C)	Mauve	4, 5, 6, 8, 9				N/A	

Notes:
1. UL Listed for use in Light and Ordinary Hazard Occupancies at a 4 to 12 inch (100 to 300 mm) top of deflector-to-ceiling distance
2. C-UL Listed for use in Light and Ordinary Hazard Occupancies at a 4 to 12 inch (100 to 300 mm) top of deflector-to-ceiling distance
3. FM Approved for use in Light Hazard Occupancies at a 4 to 12 inch (100 to 300 mm) top of deflector-to-ceiling distance
4. LPCB Approved (Ref. No. 094a & 007k) at a 4 to 6 inch (100 to 150 mm) deflector-to-ceiling distance
5. UL Listed for use in Light and Ordinary Hazard Occupancies
6. C-UL Listed for use in Light and Ordinary Hazard Occupancies
7. FM Approved for use in Light Hazard Occupancies
8. LPCB Approved (Ref. No. 094a & 007k)
9. Approved by the City of New York under MEA 354-01-E
10. Where Polyester Coated, Lead Coated, Wax Coated, and Wax-over-Lead Coated Sprinklers are noted to be UL and C-UL Listed, the sprinklers are UL and C-UL Listed as corrosion-resistant sprinklers. Where Lead Coated, Wax Coated, and Wax-over-Lead Coated Sprinklers are noted to be FM Approved, the sprinklers are FM Approved as corrosion-resistant sprinklers.

* Installed with Style 10 (1/2" NPT) or Style 40 (3/4" NPT) 3/4" Total Adjustment Recessed Escutcheon, as applicable
** 150°F (66°C) maximum ceiling temperature
*** Frame and deflector only

N/A – Not Applicable

TABLE A
SERIES TY-B HORIZONTAL AND VERTICAL SPRINKLERS
LABORATORY LISTINGS AND APPROVALS

K	SPRINKLER TYPE	SPRINKLER FINISH					
		NATURAL BRASS	CHROME PLATED	POLYESTER*	LEAD COATED	WAX COATED	WAX-OVER-LEAD COATED
5.6 1/2" NPT	HORIZONTAL SIDEWALL (TY3351)	250 psi (17,2 bar) [a] OR 175 psi (12,1 bar)					
	RECESSED HORIZONTAL SIDEWALL (TY3351)						
	VERTICAL SIDEWALL (TY3451)	175 psi (12,1 bar)					

Note:
a. The maximum working pressure of 250 psi (17,2 bar) only applies to UL Listing, C-UL Listing and Approval by the City of New York
* Frame and deflector only

TABLE B
SERIES TY-B HORIZONTAL AND VERTICAL SPRINKLERS
MAXIMUM WORKING PRESSURE

Care and Maintenance

The TYCO Series TY-B, 5.6 K-factor, Horizontal and Vertical Sidewall Sprinklers must be maintained and serviced in accordance with this section.

Before closing a fire protection system main control valve for maintenance work on the fire protection system that it controls, obtain permission to shut down the affected fire protection system from the proper authorities and notify all personnel who may be affected by this action.

The owner must assure that the sprinklers are not used for hanging any objects and that the sprinklers are only cleaned by means of gently dusting with a feather duster; otherwise, non-operation in the event of a fire or inadvertent operation may result.

Absence of an escutcheon, which is used to cover a clearance, may delay the time to sprinkler operation in a fire situation.

Sprinklers which are found to be leaking or exhibiting visible signs of corrosion must be replaced.

Automatic sprinklers must never be painted, plated, coated, or otherwise altered after leaving the factory. Modified sprinklers must be replaced. Sprinklers that have been exposed to corrosive products of combustion, but have not operated, should be replaced if they cannot be completely cleaned by wiping the sprinkler with a cloth or by brushing it with a soft bristle brush.

Care must be exercised to avoid damage to the sprinklers before, during, and after installation. Sprinklers damaged by dropping, striking, wrench twist/slippage, or the like, must be replaced. Also, replace any sprinkler that has a cracked bulb or that has lost liquid from its bulb. (Refer to Installation Section.)

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable standards of the National Fire Protection Association (e.g., NFPA 25), in addition to the standards of any other authorities having jurisdiction. Contact the installing contractor or product manufacturer with any questions.

Automatic sprinklers are recommended to be inspected, tested, and maintained by a qualified Inspection Service in accordance with local requirements and/or national codes.

P/N 57 – XXX – X – XXX

		SIN
578	HORIZONTAL SIDEWALL	TY3351
575	VERTICAL SIDEWALL	TY3451

	SPRINKLER FINISH
1	NATURAL BRASS
3	PURE WHITE (RAL9010)* POLYESTER
4	SIGNAL WHITE (RAL9003) POLYESTER
5	JET BLACK (RAL9005)** POLYESTER
6	WAX COATED 286°F (141°C) MAX
7	LEAD COATED
8	WAX-OVER-LEAD 286°F (141°C) MAX
9	CHROME PLATED

	TEMPERATURE RATING
135	135°F (57°C)
155	155°F (68°C)
175	175°F (79°C)
200	200°F (93°C)
286	286°F (141°C)
360	360°F (182°C)
000	OPEN***

Notes:
* Eastern Hemisphere sales only
** Available only for 155°F (68°C) or 200°F (93°C) temperature rated sprinklers
*** Available only for horizontal sidewall TY3351 for use in Deluge Systems ("OPEN" indicates sprinkler assembly without glass bulb, button, and sealing assembly)

TABLE C
SERIES TY-B HORIZONTAL AND VERTICAL SIDEWALL SPRINKLERS
PART NUMBER SELECTION

Color	Sprinkler Temperature Rating	Part Number
Black	135°F (57°C)	56-065-1-135
Red	155°F (68°C)	56-065-1-155
Yellow	175°F (79°C	56-065-1-175
Blue	200°F (93°C) 286°F (141°C)	56-065-1-286

TABLE D
SERIES TY-B HORIZONTAL AND VERTICAL SIDEWALL SPRINKLERS
WAX RETOUCHING STICK PART NUMBER SELECTION

Limited Warranty

For warranty terms and conditions, visit www.tyco-fire.com.

Ordering Procedure

Contact your local distributor for availability. When placing an order, indicate the full product name and Part Number (P/N).

Sprinkler Assemblies with NPT Thread Connections
Specify: Series TY-B (specify SIN), (specify K-factor), (specify Horizontal or Vertical Sidewall) Sprinklers with (specify) temperature rating, (specify) finish or coating, P/N (Refer to Table C)

Recessed Escutcheon
Specify: Style 10 Recessed Escutcheon with (specify) finish, P/N (specify*)

* Refer to Technical Data Sheet TFP770

Sprinkler Wrench
Specify: W-Type 6 Sprinkler Wrench, P/N 56-000-6-387

Specify: W-Type 7 Sprinkler Wrench, P/N 56-850-4-001

Wax Sticks
(for retouching wrench-damaged wax coating)
Specify: (specify color, below) Colored Coded Wax Stick for retouching (specify temperature rating) temperature-rated Series TY-B Sprinklers, P/N (specify)

Note: *Each wax stick is suitable for retouching up to 25 sprinklers.*

Note: *The wax used for 286°F (141°C) sprinklers is the same as for 200°F (93°C) sprinklers, and, therefore, the 286°F (141°C) sprinkler is limited to the same maximum ceiling temperature as the 200°F (93°C) sprinkler (i.e., 150°F [66°C]).*

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tyco Fire Protection Products

APPENDIX A

SAMPLE RESIDENTIAL SPRINKLER PLAN REVIEW CHECKLIST

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13D Residential Sprinkler System
Plan Review Checklist
2007 NFPA 13D, 2007 OFC, and 2008 ORSC

Date of Review: _____ Permit Number: _____

Business/Building Name: _____ Address of Project: _____

Designer Name: _____ Designer's Phone: _____

Contractor: _____ Contractor's Phone: _____

No. of Sprinklers: _____ Occupancy Classification: _____

Reference numbers following checklist statements represent an NFPA code section unless otherwise specified.

Checklist Legend: √ **or OK** = acceptable, **N** = need to provide, **NA** = not applicable

1. _____ A minimum of three sets of drawings are provided.
2. _____ System components are listed for intended use, specification data sheets are provided, 5.1.2. Nonlisted items that are permitted by the standard can be tanks, pumps, hangers, waterflow detection devices, and waterflow valves, 5.1.3.

Drawings shall show the following:

General

3. _____ Scale: a common scale shall be used and information shall be legible.
4. _____ Plot plan details illustrate the water supply connection, pipe diameters, lengths, and fittings to the building, OFC 901.2.
5. _____ Building dimensions, cross sectional views, and the location of partitions are provided, OFC 901.2.
6. _____ Type of protection for nonmetallic pipe is provided, OFC 901.2.
7. _____ Dimensions for system piping, type of pipe, and component spacing, OFC 901.2.
8. _____ Equipment symbol legend and the compass point are detailed, OFC 901.2.
9. _____ Total number of each type of sprinkler is noted on the plans, OFC 901.2.
10. _____ Type of sprinklers, K factors, temperature rating, coverage area, minimum operating pressure, and orifice size are provided, OFC 901.2.
11. _____ Dry systems are not permitted unless all components are approved and listed and it serves unheated areas, 8.3.2.
12. _____ For a dry system, or a system using a pressurized tank as a water supply source, a pressure gauge is detailed 7.3.
13. _____ Wet pipe system is used when not subject to freezing, 8.3.1.
14. _____ Type of antifreeze solution and percentage is noted on the plans, 8.3.3.2.
15. _____ Systems in areas subject to freezing shall be well insulated or shall be a dry pipe or antifreeze system, 8.3.1 and 8.3.2.
16. _____ When required, the antifreeze system is designed in accordance with Figure 8.3.3.3.1.1, and local plumbing codes, 8.3.3 and 8.3.3.1, and IFC 903.3.5.
17. _____ Stored water supply shall provide the water demand rate for 10 minutes, 7 minutes if dwelling unit is one story and less than 2,000 sq. ft., 6.1.2 and .3. Is the supply riser in a heated environment?
18. _____ A reliable water supply is provided in accordance with section 6.2.
19. _____ Is the supply riser in a heated environment?

Multipurpose Piping Systems

20. _____ Multipurpose system, without an FDC, that uses nonmetallic fittings, the fittings are designed to an operating pressure of 130 psi or greater, 5.2.5.3.
21. _____ The piping system serving both sprinkler and domestic needs is acceptable if: 1) The common water supply is serving more than 1 dwelling unit, 5 gpm is added to the sprinkler demand, 2) All pipe used is listed, 3) Pipe connected to the system serving plumbing fixtures need not be listed, 4) Permitted by the plumbing AHJ, 5) A sign adjacent to the main shutoff indicates it serves the fire sprinkler system with verbiage per the code section, 6) Devices that restrict the flow shall not be added and water treatment and filtering systems shall be bypassed, 6.3

Sprinklers

21. _____ Sprinkler location is correct according to listing criteria and sections 8.1.3 and 8.2.
22. _____ Only residential sprinklers are specified for wet systems unless listed for other uses, 7.5.2.
23. _____ Dry pendent or sidewall sprinklers are permitted to be used in unheated areas not used for living, 7.5.3.
24. _____ Sprinklers are ordinary temperature (135˚F-175˚F) when the ceiling does not exceed 100˚F, 7.5.5.1.
25. _____ Sprinklers that are in areas with ceiling temperatures of 101˚F-150˚F are intermediate temperature (175˚F-225˚F), 7.5.5.2.

26. _____ Intermediate temperature sprinklers are used in skylights exposed to direct sun, in unvented concealed spaces under uninsulated roofs or in unvented attics, and near heat sources, Table 7.5.5.3, 7.5.5.3.
27. _____ Ceiling pockets are sprinkled unless the pocket volume is 100 sq. ft. or less, its depth is 1 ft. or less, the floor below is protected, it is separated from other pockets by at least 10 ft., and the finish material is non-combustible or limited-combustible, 8.6.7
28. _____ Each sprinkler coverage area is within its listing limitation, 8.1.3 & OFC 901.2.
29. _____ Sloped ceiling spacing is in accordance with Figure 8.1.3.1.3.1 and section 8.1.3.1.3.
30. _____ Closets, which may include mechanical equipment, that is limited to 400 cu. ft., a single sprinkler is provided and is located at the highest ceiling height, 8.2.5.1.
31. _____ Pendent sprinklers are at least 3 ft. from obstructions e.g. light fixtures, ceiling fans, etc. or in accordance with Table 8.2.5.4.2 and section 8.2.5.2. Sprinkler locations for continuous obstructions are in compliance with 8.2.5.4.
32. _____ Sidewall sprinklers are at least 5 ft. from obstructions e.g. light fixtures, ceiling fans, etc. or in accordance with Table 8.2.5.5.2 and section 8.2.5.3. Sprinkler locations for continuous obstructions are in compliance with 8.2.5.5.
33. _____ Soffits and cabinets are provided sprinkler coverage in accordance with 8.2.5.6.
34. _____ Dry pipe and preaction systems can use only listed sprinklers which are installed in accordance with 8.3.4.1.1.
35. _____ Dry pipe and preaction systems can use K-factors exceeding 4.0 and less than 5.6 with corrosion resistant or galvanized coated pipe, 8.3.4.1.2.
36. _____ Dry pipe and preaction systems can use K-factors 5.6 or greater with pipe in compliance with section 5.2.
37. _____ Dry pipe and double interlock preaction systems have calculations showing water delivery at the most remote sprinkler is within 15 seconds, Table 8.3.4.3.1.
38. _____ Dry pipe and preaction systems riser is in a location that is protected from freezing conditions, 8.3.4.4.
39. _____ Dry pipe and preaction systems detection is provided in all sprinkler protected compartments and the detection system plans are provided, 8.3.4.5.
40. _____ Dry pipe and preaction systems piping details have pipe pitched at least ¼ in. for each 10 ft. for drainage, 8.3.4.7.
41. _____ Dry pipe and preaction systems air maintenance system is detailed and equipment data sheets are provided, 8.3.4.9.
42. _____ Sprinklers are in all areas except bathrooms 55 sq. ft. or less; clothes closets 24 sq. ft. or less with noncombustible or limited-combustible surface materials, and the least dimension does not exceed 3 ft.; garages, open attached porches, and carports; attics, crawl spaces, and concealed spaces not used; covered unheated projections from buildings at entrances/exits as long as there is another means of egress from the dwelling unit, 8.6.

Alarms

43. _____ Local flow alarm location and inspector's test connection are provided and detailed, except if the dwelling has smoke detectors in compliance with the building code, 7.6.

Hydraulic Calculations or Design Discharge

44. _____ Reference points match with plans.
45. _____ Pipe size references match the plans and size is determined by hydraulic calculations based on one of the following methods in section 8.4.4 or 8.4.5, or using the calculation methods in NFPA 13.
46. _____ Hydraulic calculations are also required when a system is gridded, looped, or connected to a city main less than 4 in., 8.4.7-8.4.9.
47. _____ Legend for calculation abbreviations is provided.
48. _____ Sprinkler specification matches what is on the plans and hydraulic calculations.
49. _____ Water flow information such as static psi, residual psi, and available gpm at 20 psi residual is provided.
50. _____ Hydraulic calculations can be provided using one of three methods described in section 8.4.4 when the system is connected to a city main of at least 4 in. in size and typical calculations include static psi, pipe length, discharge gpm, K for drops, elevation data, friction loss, friction loss data for gate valve and backflow prevention device and equivalent pipe length, 8.4.4.
51. _____ Sprinklers without a listed discharge criteria: a single sprinkler discharge is not less than 18 gpm and a multi-sprinkler discharge design is not less than 13 gpm, 8.1.1.1.1, and .2.
52. _____ Sprinklers with a listing discharge criteria: the system provides at least the flow required for multiple and single sprinkler operation as specified by the listing, 8.1.1.2.1, and the flow must produce a minimum density of .05 gpm/ft^2 to the design sprinklers, 8.1.1.2.2.
53. _____ Sprinkler design for flat, smooth ceilings consists of up to 2 sprinklers within the same compartment with the largest water demand, 8.1.2.

Pipe Support and Hangers

54. Piping support shall comply with submitted manufacturers instructions and/or listing criteria. The plumbing code will be consulted for piping that does not have support criteria provided. Lateral movement is prevented for pipe laid on joists or rafters and in general, pipe movement is to be supported to restrain movement, 7.4.

Pipe and Valves

55. _____ One control valve is provided for both the domestic water and sprinkler, unless a separate control valve is provided for the sprinkler system, 7.1.1 and it is electronically supervised, IFC 903.4
56. _____ A drain and test connection is provided in accordance with 7.2.1.
57. _____ Each portion of trapped dry system piping that is subject to freezing is provided a drain, 7.2.3.
58. _____ A waterflow test connection is provided if a waterflow alarm is provided, 7.2.4.
59. _____ Type and the diameter of pipe are provided. Pipe shall comply with Tables 5.2.1.1 and 5.2.2.2, 5.2.1.
60. _____ At least 1 in. steel pipe or at least ¾ in. for other than steel pipe is used in the sprinkler system, 8.4.3.
61. _____ Network systems are allowed ½ in. nonmetallic pipe or copper pipe with listed special fittings when in compliance with 10 conditions specified in 8.4.3.3.

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Page 1 of 3 *Plan Check Number* _____

RESIDENTIAL FIRE SPRINKLER PLAN REVIEW CHECKLIST

1. Legal Owner
   a. Name _____
   b. Address _____
   c. Phone No. _____
2. Installing Contractor/Designer
   a. Name _____
   b. Address _____
   c. Phone No. _____

CIRCLED ITEMS EITHER REQUIRE CLARIFICATION, MODIFICATION, CHANGE, AND/OR A NOTE ON THE PLANS.

Inspector Test Valve location: _____
Sprinkler Riser location: _____
Spare Head Box Location: _____
Shut off valve location: _____
Thomas Register Map Number and Grid: _____

3) Job Site
   a) Location (Including street address)

4) Site Plan
   a) Water main connection
   b) Water main connection elevation _____
   c) Finished floor elevation _____
   d) Meter size (min. 1") _____
   e) Size of Underground
      1) Meter to main (1" max. by Water Dept.) _____
      2) Meter to residence _____
   f) Underground material
      3) Meter to main (Copper type "K") _____
      4) Meter to residence _____
   g) Scale of drawing _____
   h) North arrow
   i) Length of underground
      3) Meter to main _____
      4) Meter to residence _____

5) Vicinity Map
   a) North arrow
   b) Scale _____
   c) Cross Street
   d) Job site identified

6) Floor Plan (for each level) (include options)
   a) Scale _____
   b) North arrow
   c) Room occupancies indicated
   d) Location of partitions
   e) Size of all areas not requiring sprinklers
   f) Ceiling construction and height
      1) Beams – maximum beam depth that can be drilled for a fire sprinkler head is **8 inches or as per manufacturer sprinkler head cut sheet**
      2) Fans
      3) Fixtures
      4) Obstructions
   g) Any room under stairway (include baths) shall be protected.
   h) Location of all high temperature appliances and devices (i.e. fireplaces, stove, ranges, ovens, dryers, furnaces, space heaters, water heaters, etc.)
   i) Show heat zones per manufacturer's Specifications
   j) Spare head cabinet location noted
   k) Garages within 10' (airspace) or attached covered walkways shall be protected
   l) Square footage of area to be protected _____ _____

**********Required Plan Submittals**********

a) Minimum 4 copies of plans
b) Minimum 3 copies of calculations
c) Cut sheets of sprinklers and any new material (1 set)

 Plan Check Number _____

7) Fire Sprinkler Riser
   a) Location (shall be inside the garage unless approved by the Fire Prevention Bureau)
   b) Riser detail (see attached Riser Detail)
   c) Check valve (resilient seated swing check)
   d) Pressure relief valve set @ 150 psi
   e) Main drain valve (½ “)
   f) Exterior aboveground shut-off (ball valve)
   g) Riser/Pipe material type _____
   h) Flow switch
   i) Gauge and range
   j) Location of alarm bell(s) and size (min. 8”) _____
   k) An additional 8” min. bell or interior horns required on dwellings with 5,000 or more sq.ft.

8) Sprinkler Piping
   a) Material _____
   b) All pipe sizes indicated (1” min. pipe diameter)
   c) Inspector’s test valve type and location keyless, remote from riser, exterior access with sign and splash block located 4’ to 6’ above grade

9) Water Supply
   a) Water department name
   b) Water department phone number
   c) Water department contact person
   d) Available water pressure and elevation (By Water Dept. w/copy of e-mail or letter)
   e) Date of information obtained _____
   f) Fire approved pressure regulator required when static pressure is above 150 psi (see attached)

10) Sprinklers
   a) Manufacturer and type of heads _____ _____
   b) Calculated spacing noted on plans _____
   c) Total quantity to be installed _____
   d) Special high temperature heads, garage, etc.
   e) Dimensions to walls
   f) Dimensions to adjacent sprinklers
   g) Sprinklers per manufacturer’s listing providing total protection
   h) FAU’s in attic shall be protected
   i) Enclosed patios/porches shall be protected
   j) Quick response commercial heads required in garages with a maximum 150 sq. ft. spacing per head.

11) Full Height Cross Section
   a) Location where section is taken
   b) Scale _____
   c) Piping and heads shown
   d) Elevation of building finished floor _____
   e) Elevation of piping and heads shown _____

12) Hydraulic Calculations
   a) Two most hydraulically demanding heads
   b) Three (3) most hydraulically demanding heads for vaulted or sloped and lofts ceilings unless head is listed for sloped ceilings
   c) Four (4) most hydraulically demanding heads when dwelling is 10,000 or more sq. ft.
   d) Hydraulic reference points indicated
   e) Source pressure indicated
   f) Source elevation indicated
   g) Elevation at remote heads
   h) Proper Hazen-Williams coefficient used
   i) Loss through all fittings calculated
   j) Systems demand 10% below available supply
   k) Proper sprinkler head data used (GPM, PSI, K-factor)
   l) Plans note the required demands (GPM and required pressure at source)

13) General Notes and Information on Plans
   a) Legend
   b) All material and installation to conform to the standards of NFPA-13D
   c) Sprinkler heads omitted from bathroom due to non-combustible fixtures and not exceeding 55 square feet
   d) Waterflow alarm(s) shall be clearly audible in all living spaces over background noise with all doors closed
   e) Exterior exposed steel piping painted
   f) Storage in attic and crawl spaces is not allowed unless protected with sprinklers
   g) Access to areas under stairwells shall be protected (closets, baths, etc.)
   h) All penetrations through firewalls, such as walls and ceilings between attached garage and residence, will be sealed in an approved manner to maintain the integrity of the firewall
   i) Pipe hangers shall be in accordance with NFPA-13D
   j) Drilling or notching of structural members shall be performed in strict accordance with the current UBC
   k) Three heads of each type used PLUS head wrench shall be provided in spare head cabinet
   l) Head guards to be provided on all garage heads
   m) As-Built plans and/or calculations shall be required when the following occur:
      (1) Change the type of heads
      (2) Change spacing of heads
      (3) Change the location of the riser (approved location)
      (4) Change of major pipe runs
   n) As-Built plans and calculations shall be approved prior to inspection approval and will require payment of a new plan check fee.

**********Required Plan Submittals**********

a) Minimum 4 copies of plans
b) Minimum 3 copies of calculations
c) Cut sheets of sprinklers and any new material (1 set)

 Plan Check Number _____

ADDITIONAL CORRECTIONS/COMMENTS

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

RECHECK REQUIRED: [ ] YES [ ] NO

CORRECTIONS MADE AND APPROVED BY:

_____ _____

Fire Department Signature Date

**********Required Plan Submittals**********

a) **Minimum 4 copies of plans**
b) **Minimum 3 copies of calculations**
c) **Cut sheets of sprinklers and any new material (1 set)**

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Phoenix Fire Department

Plan Review of 13-D Systems

REFERENCED FIRE CODES NFPA 13-D, 2002 ed. and IFC Section 903, 2003 ed.

OBJECTIVE OF THIS CHECKLIST This checklist is designed to guide the plan reviewer and contractor for the plan review of 13-D systems. This checklist shall be used in conjunction with the appropriate NFPA, Phoenix Fire Code, and IBC code books. This checklist is merely a general guideline to assist in the plan submittal and reviewer.

SEQUENCED PLAN REVIEW

Reference to Phoenix Fire Code, Section 903 (Automatic Sprinkler Systems) and NFPA 13-D along with the appropriate suppressant system manual.

REQUIRED PLAN REVIEW INFORMATION

REQUIREMENT	Section	Complete
The following points need to be addressed when conducting a plan review for 13-D systems:		
❑ Verify plan has address.	903.1.2	YES ❑ NO❑
❑ Verify installing contractor's information is provided on plan.	903.1.2	YES ❑ NO❑
❑ Verify the plan being reviewed is a 13-D system.	903.3.1.3	YES ❑ NO❑
❑ Check and verify the scale.	105.2.8.1	YES ❑ NO❑
❑ Check to ensure the appropriate sprinkler cut sheets are included.	903.1.2	YES ❑ NO❑
❑ Check to ensure hydraulic calculation sheets are provided.	901.2	YES ❑ NO❑
❑ Verify areas being calculated are in fact the most demanding areas.	903.1.2	YES ❑ NO❑
❑ Check and verify K-factor, starting GPM, and PSI, for type of sprinkler heads being calculated, are correct per data sheet.	Plan Review	YES ❑ NO❑
❑ Check calculations against the plans for the following: fittings, pipe sizing/lengths.	Data Sheets	YES ❑ NO❑
❑ Verify 5 GPM has been deducted for domestic water supply.	Plan Review	YES ❑ NO❑
❑ Verify 10 PSI has been deducted from static pressure (NOT 10%).	13D 6.3	YES ❑ NO❑
❑ Check spacing between sprinkler heads and spacing off walls.	903.3.1.8.3	YES ❑ NO❑
❑ Check coverage in areas with soffits to ensure adequate protection. (Use figure 8.10.6.1.2b in NFPA 13)	Plan Review	YES ❑ NO❑

Phoenix Fire Department

Plan Review of 13-D Systems

REQUIREMENT	Section	Complete
❑ Ensure garages, carports, and balconies below living spaces are covered with sprinklers.	IFC 903.3.1.3.1	YES ❑ NO❑
❑ Ensure that any sprinklers that are exposed to the outside elements and subjected to freezing are insulated.	IFC 903.3.1.9	YES ❑ NO❑
❑ If a ceiling has beams and slopes, check attached flow chart and manufacturers cut sheets.	Flow Chart Cut Sheets	YES ❑ NO❑
❑ Check for any obstruction and reference accordingly.	NFPA 13 Section 8.10	YES ❑ NO❑
❑ Check to ensure a water meter is installed and of the correct size to accommodate the sprinkling system (should be indicated on plans).	IFC 903.3.1.3.4	YES ❑ NO❑
❑ Ensure a water meter has been included and hydraulically accounted for.	IFC 903.3.1.3.4	YES ❑ NO❑

APPENDIX B

FIRE SPRINKLER WORKING PLANS

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Fire Sprinkler Working Plans

National Fire Protection Association (NFPA) Standard 13, *Standard for the Installation of Sprinkler Systems*, requires that specific information be included on sprinkler system working plans so the authority having jurisdiction (AHJ) can review them.

The following list is intended for large-scale commercial projects, and generally provides more information than is needed for a typical residential plan. The items marked with an asterisk (*) are appropriate for a residential plans review submittal.

Working plans must be drawn to an indicated scale, on sheets of uniform size with a plan of each floor, and must include the following items:

1 *Name of owner and occupant.
2 *Location, including street address.
3 *Point of compass.
4 *Full-height cross-section, or schematic diagram, including structural member information if required for clarity and including ceiling construction/slope and method of protection for nonmetallic piping.
5 *Location of partitions.
6 Location of fire walls.
7 Occupancy class of each area or room.
8 *Location and size of concealed spaces, closets, attics and bathrooms.
9 *Any small enclosures in which no sprinklers are to be installed.
10 *Size of city main in street and whether dead end or circulating; if dead end, direction and distance to nearest circulating main; and city test results and system elevation relative to test hydrant or test location.
11 *Other sources of water supply, with pressure or elevation.
12 *Make, model, Sprinkler Identification Number (SIN) and nominal K-factor of sprinklers.
13 *Temperature rating and location of high-temperature sprinklers.
14 Total area protected by each system on each floor.
15 Number of sprinklers on each riser on each floor.
16 Total number of sprinklers on each dry pipe system, preaction system, combined dry pipe preaction system or deluge system.
17 Approximate capacity in gallons of each dry pipe system.
18 *Pipe type and schedule of wall thickness.
19 *Nominal pipe size and cutting lengths of pipe (or center-to-center dimensions). Where typical branch lines prevail, it shall be necessary to size only one typical line.
20 Location and size of riser nipples.
21 Type of fittings and joints and locations of all welds and bends. The contractor shall specify on drawing any sections to be shop-welded and the type of fittings or formations to be used.
22 *Type and locations of hangers, sleeves, braces and methods of securing sprinklers when applicable.
23 *All control valves, check valves, drain pipes and test connections.
24 *Make, model, type and size of alarm or dry pipe valve.
25 *Make, model, type and size of deluge or preaction valve.
26 *Kind and location of alarm bells.

27 Size and location of standpipe risers, hose outlets, hand hose, monitor nozzles and related equipment.
28 Private fire service main sizes, lengths, locations, weights, materials, point of connection to city main; the sizes, types and locations of valves, valve indicators, regulators, meters and valve pits; and the depth that the top of the pipe is laid below grade.
29 Piping provisions for flushing.
30 Where the equipment is to be installed as an addition to an existing system, enough of the existing system indicated on the plans to make all conditions clear.
31 For hydraulically designed systems, the information on the hydraulic data nameplate.
32 *A graphic representation of the scale used on all plans.
33 *Name and address of contractor.
34 *Hydraulic reference points shown on the plan that correspond with comparable reference points on the hydraulic calculation sheets.
35 The minimum rate of water application (density), the design area of water application, in-rack sprinkler demand, and the water required for hose streams both inside and outside.
36 The total quantity of water and the pressure required noted at a common reference point for each system.
37 *Relative elevations of sprinklers, junction points, and supply or reference points.
38 If room design method is used, all unprotected wall openings throughout the floor protected.
39 Calculation of loads for sizing and details of sway bracing.
40 The setting for pressure-reducing valves.
41 *Information about backflow preventers or water metering devices (manufacturer, size, type).
42 *Information about antifreeze solution used (type and amount).
43 Size and location of hydrants, showing size and number of outlets and if outlets are to be equipped with independent gate valves. Whether hose houses and equipment are to be provided, and by whom, shall be indicated. Static and residual hydrants that were used in flow tests shall be shown.
44 *Size, location and piping arrangement of fire department connections (if any).
45 *Information about water system attachments: water softeners, purifiers, filters or other devices that may restrict flow (manufacturer, make, model, size).

Hydraulic Calculations

When the submittal is for a hydraulically designed sprinkler system, hydraulic calculation forms with the following information must be included.

Summary Sheet

1 *Date.
2 *Location.
3 *Name of owner and occupant.
4 *Building number or other identification.
5 Description of hazard.
6 *Name and address of contractor or designer.
7 *Name of approving agency.
8 *System design requirements, as follows:
   a. Design of water application in square feet.
   b. Minimum rate of water application (density), gallons per minute (gpm)/square foot.
   c. Area per sprinkler in square feet.
   d. Number of design sprinklers.
9 *Total water requirements as calculated, including allowance for inside hose, outside hydrants, and water curtain and exposure sprinklers.
10 Allowance for in-rack sprinklers in gpm.
11 Limitations (dimension, flow and pressure) on extended coverage or other special listed sprinklers.

*Detailed Worksheets

1 Sheet number.
2 Sprinkler description and discharge constant (K).
3 Hydraulic reference points.
4 Flow in gpm.
5 Pipe size.
6 Pipe lengths, center-to-center of fittings.
7 Equivalent pipe lengths for fittings and devices.
8 Friction loss in pounds per square inch (psi)/foot of pipe.
9 Total friction loss between reference points.
10 In-rack sprinkler demand balanced to ceiling demand.
11 Elevation head in psi between reference points.
12 Required pressure in psi at each reference point.
13 Velocity pressure and normal pressure if included in calculations.
14 Notes to indicate starting points or reference to other sheets or to clarify data shown.
15 Diagram to accompany gridded system calculations to indicate flow quantities and directions for lines with sprinklers operating in the remote area.
16 Combined K-factor calculations for sprinklers on drops, armovers or sprigs where calculations do not begin at the sprinkler.

*Graph Sheet

1 Water supply curve.
2 Sprinkler system demand.
3 Hose demand (where applicable).
4 In-rack sprinkler demand (where applicable).

Hydraulic Symbols

When the submittal is for a hydraulically designed sprinkler system, hydraulic calculation forms with the following abbreviations or symbols should be used. Some engineers and designers will use different abbreviations.

Symbol or Abbreviation	Item
p	Pressure in pounds psi
gpm	U.S. gallons per minute
q	Flow increment in gpm to be added at a specific location
Q	Summation of flow in gpm at specific location
P_t	Total pressure in psi at a point in a pipe or tube
P_f	Pressure loss due to friction between points indication in a location column
P_e	Pressure due to elevation difference between two points. This can be a plus or minus value. If minus, the minus sign (-) must be used. If plus, no sign is needed.
P_v	Velocity pressure in psi at a point in a pipe
P_n	Normal pressure in psi at a point in a pipe
E	90 degree ell
EE	45 degree ell
Lt.E	Long-turn elbow
Cr	Cross
T	Tee-flow turned 90 degrees
GV	Gate valve
BV	Butterfly (wafer) check valve
Del V	Deluge valve
ALV	Alarm valve
DPV	Dry pipe valve
CV	Swing check valve
WCV	Butterfly (wafer) check valve
St	Strainer
psi	Pounds per square inch
v	Velocity of water in pipe in feet per second
K	K-factor
C-factor	Friction loss coefficient

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APPENDIX C

KEY FORMULAS

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Key Formulas

This list includes essential fire protection mathematical formulas for sprinkler plans review.

1. **Area.**

To compute the area of a square or rectangle:

$$L \times W = \text{area}$$

Where:

L = length of one side of the square/rectangle
W = width of one side of the square/rectangle

Example: What is the area of a room that measures 26 feet by 14 feet?

$$26 \times 14 = 364 \text{ ft}^2$$

2. **Water flow from a single sprinkler.**

To compute the water flow in gallons per minute (gpm) from a single sprinkler:

$$Q = K\sqrt{P}$$

Where:

Q = quantity of water in gpm
K = the sprinkler K-factor, a coefficient of its outlet area
P = pressure in pounds per square inch (psi)

Example: What is the flow in gpm of a sprinkler with a K-factor of 5.6 and a flowing pressure of 29 psi?

$$Q = 5.6\sqrt{29}$$
$$Q = 5.6 \times 5.3851$$
$$Q = 30.1569 \text{ gpm}$$

3. **Determine the K-factor of a single sprinkler.**

To determine the K-factor of a sprinkler:

$$K = Q/\sqrt{P}$$

Where:

Q = quantity of water in gpm
K = the sprinkler K-factor, a coefficient of its outlet area
P = pressure in psi

Example: What is the K-factor of a sprinkler when the flow is 68 gpm and the operating pressure is 43 psi?

$$K = 68/\sqrt{43}$$
$$K = 68/6.557$$
$$K = 10.3705$$

4. **Area of application adjustment for quick response sprinklers (QRSs) in wet pipe light or ordinary hazard occupancies with ceilings 20 feet or less.**

To determine the adjustment in the area of application when ceiling height is greater than or equal to 10 feet and less than or equal to 20 feet:

$$y = -3x/2+55$$

Where:

y = percentage reduction to design area (area of application)
x = maximum ceiling height

Note:

For ceiling height < 10 feet, y = 40
For ceiling height > 20 feet, y = 0

Example: What is the allowable reduction of area of application for a ceiling height of 15 feet when QRSs are employed on a wet pipe system in a light or ordinary hazard occupancy?

$$y = -3x/2+55$$
$$y = -3(15)/2+55$$
$$y = -45/2+55$$
$$y = -22.5+55$$
$$y = 32.5\%$$

5. **Coverage area per sprinkler.**

To determine the area per coverage of a single sprinkler:

$$S \times L = A_s$$

Where:

S = the **larger** of twice the distance to the wall or obstruction or the distance to the next sprinkler on a branch line.
L = the **larger** of twice the distance to the wall or obstruction or the distance to the adjacent branch line.
A_s = area per coverage of a single sprinkler.

Example: What is the area per coverage of a sprinkler that is 6 feet, 6 inches from the nearest wall; 9 feet, 10 inches from the nearest sprinkler on the same branch line; and 10 feet between branch lines?

S = 13 (6 feet, 6 inches x 2 is greater than 9 feet, 10 inches)
L = 10

$A_s = 13 \times 10$
$A_s = 130 \text{ ft}^2$

6. **Rectangular shape of the remote area.**

To establish the long side of the rectangular dimension of the remote area:

$$1.2 \times \sqrt{A}$$

Where:

A = the area of application (remote area).

Example: What is the long side of the rectangular dimension of the remote area for an area of application of 3,250 square feet?

$1.2 \times \sqrt{3{,}250}$
1.2×57.008
68.4096 ft

7. **Number of design sprinklers in the remote area.**

To establish the number of sprinklers required in the remote area:

$$\frac{\text{Area of operation (remote area)}}{\text{Area per sprinkler*}}$$

* As established by actual measurement, not NFPA 13 tables.

Example: How many sprinklers must be included in a light hazard occupancy remote area of 2,725 square feet with sprinkler spacing of 215 square feet?

2,725/215 = 12.67 rounded to 13

8. **Number of sprinklers per branch line within the remote area.**

To establish the number of design sprinklers on each branch line within the remote area:

$$(1.2 \times \sqrt{A})/S$$

Where:

A = the area of application (remote area)
S = the spacing between sprinklers on a branch line

Example: What is the number of design sprinklers per branch line in a remote area of 3,250 square feet with sprinklers spaced 10 feet, 6 inches on center?

$(1.2 \times \sqrt{3,250})/10.5$
$(1.2 \times 57.008)/10.5$
$68.4096/10.5$
6.515 rounded to 7

9. **Pressure loss due to elevation.**

To establish the amount of pressure loss due to elevation:

$$0.433 \times h$$

Where:

h = height in feet

Example: How much pressure is lost due to differences in elevation between 87 feet and 46 feet above sea level (ASL)?

87 – 46 = 41-foot difference
41 x 0.433 = 17.75 psi loss due to elevation

10. **Velocity pressure.**

To establish the amount of velocity necessary to keep water moving in the pipe or tube:

$$\frac{P_v = 0.001123Q^2}{D^4}$$

Where:

P_v = velocity pressure in psi
Q = flow in gpm
D = inside diameter (in inches) of the pipe or tube

Example: What is the velocity pressure in a 1-inch Schedule 40 branch line flowing 23 gpm?

$$\frac{P_v = 0.001123(23)^2}{1.049^4}$$

$$\frac{P_v = 0.001123(529)}{1.21008}$$

$$\frac{P_v = 0.594067}{1.21008\text{psi}}$$

$$P_v = 0.4909 \text{ psi}$$

11. **Normal pressure.**

To determine normal pressure (which is the pressure acting perpendicularly against pipe walls):

$$P_n = P_t - P_v$$

Where:

P_n = normal pressure
P_t = total pressure (elevation and loss due to friction) in psi
P_v = velocity pressure in psi

Example: What is the normal pressure in a pipe or tube when the total pressure is 58 psi and the velocity pressure is 36 psi?

$$P_n = 58 - 36$$
$$P_n = 12 \text{ psi}$$

12. **Pressure loss due to friction.**

To establish the amount of pressure loss due to friction within the pipe or tube:

$$p = \frac{4.52Q^{1.85}}{C^{1.85}d^{4.87}}$$

Where:

p = pressure loss in psi per foot of pipe
Q = rate of flow in gpm
C = coefficient of friction
d = inside diameter of the pipe or tube in inches

Example: What is the friction loss per foot of pipe for a 1 1/4-inch Schedule 40 chlorinated polyvinyl chloride (CPVC) plastic tube flowing 29 gpm?

$$p = \frac{4.52(29^{1.85})}{(150^{1.85})(1.25^{4.87})}$$

$$p = \frac{4.52(507.50)}{(10{,}611.305)(2.9645)}$$

$$p = \frac{2293.9}{31{,}357.215}$$

$$p = 0.73158 \text{ psi/ft}$$

13. **C-factor multipliers.**

To convert the value of C from 120 for determining equivalent pipe lengths:

Value of C	100 Unlined cast or ductile iron, black steel (dry)	120 Black steel (wet) or galvanized	130	140 Cement lined cast or ductile iron, asbestos cement, concrete	150 Plastic, copper tube, stainless steel
Multiplying factor	0.713	0.00	1.16	1.33	1.51

Example: What is the equivalent length of pipe for a 4-inch 90-degree long-turn elbow made of cast iron, compared to a black steel pipe on a wet-pipe sprinkler system?

From NFPA 13, Table 27.2.3.1.1, a four-inch 90-degree long-turn elbow is equivalent to 6 feet of pipe. To convert that to C = 100, multiply 6 x 0.713 = 4.278 equivalent feet.

14. **Velocity of water in feet per second.**

To establish the velocity flow in feet per second:

$$V = \frac{0.4084Q}{d^2}$$

Where:

V = flow velocity in feet per second
Q = flow rate in gpm
d = internal pipe diameter in inches

Example: What is the flow velocity in feet per second for a 1-inch Schedule 40 branch line flowing 22 gpm?

$$V = \frac{0.4084(22)}{1.10041^2}$$

$$V = 8.98 \text{ feet per second}$$

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ACRONYMS

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ACRONYMS

AC	alternating current
AHJ	authority having jurisdiction
ASL	above sea level
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
BPVC	Boiler and Pressure Vessel Code
CPVC	chlorinated polyvinyl chloride
CRR	Community Risk Reduction
FDC	Fire Department Connection
FM	Factory Mutual
gpm	gallons per minute
HUD	U.S. Department of Housing and Urban Development
IBC	International Building Code
ICC	International Code Council
IFC	International Fire Code
IG	Instructor Guide
IRC	International Residential Code
MIC	microbiologically influenced corrosion
NFA	National Fire Academy
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
OS&Y	outside stem and yoke

PB	polybutylene
PE	polyethylene
PEX	cross-linked polyethylene
PIV	post indicator valve
PRV	pressure reducing valve
psi	pounds per square inch
PSID	pounds per square inch differential
QRS	quick response sprinkler
RSPR	"Residential Sprinkler Plan Review"
RTI	Response Time Index
SAW	Student Activity Worksheet
SDR	Standard Dimension Ratio
SIN	Sprinkler Identification Number
SM	Student Manual
UL	Underwriters Laboratories
USFA	U.S. Fire Administration
V	volt
WIV	wall indicator valve